Frankfurt School
UNEP Collaborating Centre
for Climate & Sustainable Energy Finance

GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2012

1972-2012:
Serving People
and the Planet

Bloomberg
NEW ENERGY FINANCE

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FOREWORD FROM ACHIM STEINER

In 2011, global investment in the renewable energy sector hit another record, up 17% to $257 billion. This was a six fold increase on the 2004 figure and 93% higher than the total in 2007, the year before the world financial crisis. There may be multiple reasons driving this renewable investment, from strengthening regulatory frameworks to decreasing costs — whatever the drivers, the strong and sustained growth of the sector is a major factor that is assisting many countries towards a transition to a low-carbon, resource-efficient Green Economy.

This sends a strong signal of opportunity to world leaders and delegates meeting later this month at the Rio+20 Summit: namely that transforming sustainable development from patchy progress to a reality for seven billion people is achievable when existing technologies are combined with inspiring policies and decisive leadership.

Furthermore, in 2011, renewable power (excluding large hydro) accounted for 44% of new generation capacity added worldwide in 2011, up from 34% in 2010. The $237 billion invested in building these green power plants compares with $223 billion of net new expenditure annually on building additional fossil-fuelled power plants globally last year. So we're certainly seeing a green growth trajectory in the power sector, even if we have quite some way to go to achieve an energy mix that is truly sustainable.

With this goal in mind, in 2012 UN Secretary-General Ban Ki-moon is leading a global initiative called Sustainable Energy for All aimed at mobilising action in support of three interlinked objectives to be achieved by 2030: providing universal access to modern energy services; doubling the global rate of improvement in energy efficiency; and doubling the share of renewable energy in the global energy mix.

Pushing forward on the energy agenda can assist in a defining and decisive outcome at Rio+20 including in support of the proposed Sustainable Development Goals that could be adopted in 2015. Other commitments on the table at the Summit can also assist the evolution of clean energy including governments agreeing to address the hundreds of billions of dollars worth of annual fossil-fuel subsides; expanding sustainability reporting by companies globally; and boosting sustainable procurement by central and local government.

There are many areas where sustainable development is ready for a major acceleration and scaling-up—clean energy systems, by dint of their technology, the costs, the employment potential and the opportunities, are among the ripest at Rio+20.

Achim Steiner
UN Under-Secretary General and UNEP Executive Director

FOREWORD FROM UDO STEFFENS

In 1992, world leaders met at the Earth Summit in Rio de Janeiro. They agreed on a road map for sustainable development of the global society. Important elements to achieve a sustainable future are economic development and investment while reducing greenhouse gas emissions, increasing resource efficiency and improving human well-being and social inclusion. In short: trying to decouple growth and social welfare from the rise in energy consumption of all sorts. Nearly 20 years later, nations are again gathering in Rio. They face a world that has undergone dramatic change.

The transition towards green - resource-efficient, low-emission - economies has picked up speed. New renewable technologies such as wind, photovoltaic and biofuels were introduced, developed and adopted. The capacity deployed was small and, although technologies were still expensive, overall investment levels were low.

In 2011, investments in renewable energy have almost reached the level of investments in power generation based on fossil fuels. Globally, they have passed $250 billion per year, including large hydro. New business opportunities are arising and new jobs are being created. The contribution to GDP is considerable. Increasingly, clean energy is provided to industries and people around the globe.

The renewable energy sector will continue to grow. However, the crisis in the world economy, the turbulence in the global finance industry, public debts of modern welfare states and new potent global competitors from emerging economies are changing the game.

Reduced costs to deploy renewable energy foster the investment boom. They support and enable the transition towards a green economy. Others, often even technology-pioneering companies, suffer from increased competition in the sector. In fact, the present situation is characterised by painful disparities between the performances of different companies, and different countries, trying to benefit from the rapid transition towards renewable energies. The decline in costs of important renewable technologies is starting to challenge fossil-fuel alternatives, even without effective carbon prices or direct subsidies to the producer of renewable energy.

Increasing competition has been accompanied by the bankruptcies of several significant solar manufacturers in the US and Germany in late 2011 and early 2012. Some actors have been leaving the stage of renewables, and new players are emerging. Nevertheless, the renewables sector shows all elements of a highly dynamic and vibrant industry - not only from an investment perspective. I am convinced it will offer exciting career opportunities for years to come. The new Global Trends Report provides us with the data and the reasons why.

Udo Steffens
President and CEO, Frankfurt School of Finance & Management

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METHODOLOGY AND DEFINITIONS

All figures in this report, unless otherwise credited, are based on the output of the Desktop database of Bloomberg New Energy Finance – an online portal to the world's most comprehensive database of investors, projects and transactions in clean energy.

The Bloomberg New Energy Finance Desktop collates all organisations, projects and investments according to transaction type, sector, geography and timing. It covers 52,500 organisations (including start-ups, corporate entities, venture capital and private equity providers, banks and other investors), 33,500 projects and 30,500 transactions.

METHODOLOGY

The following renewable energy projects are included: all biomass and waste-to-energy, geothermal, and wind generation projects of more than 1MW; all hydropower projects of between 1MW and 50MW; all wave and tidal energy projects; all biofuel projects with a capacity of one million litres or more per year; and all solar projects, with those less than 1MW estimated separately and referred to as small-scale projects, or small distributed capacity, in this report.

The 2012 Global Trends report concentrates on renewable power and fuels and does not cover energy-smart technologies such as smart grid, electric vehicles and power storage – except in the box at the end of Chapter 2.

Where deal values are not disclosed, Bloomberg New Energy Finance assigns an estimated value based on comparable transactions. Deal values are rigorously back-checked and updated when further information is released about particular companies and projects. The statistics used are historic figures, based on confirmed and disclosed investment.

Annual investment in small-scale and residential projects such as rooftop solar is estimated. These figures are based on annual installation data, provided by industry associations and REN21. In Chapter 5, we have also stated estimates for solar water heaters, which do not generate power and are therefore excluded from the main small-scale projects figure and from the overall total for investment in renewable energy. Bloomberg New Energy Finance continuously monitors investment in renewable energy. This is a dynamic process: as the sector's visibility grows, information flow improves. New deals come to light and existing data are refined, meaning that historic figures are constantly updated.

This 2012 report contains revisions to a number of investment figures published in the 2011 UNEP Global Trends In Renewable Energy Investment report. Revisions reflect improvements made by Bloomberg New Energy Finance to its data during the course of the last 12 months. Specific improvements in the last year have included enhanced coverage of projects in southeast Asia, better coverage of small hydropower, and the introduction of intensive quality checks for every quarter's data. Some of the tables in this report contain numbers that will add up slightly differently to the totals stated - this reflects rounding issues.

DEFINITIONS

Bloomberg New Energy Finance tracks deals across the financing continuum, from R&D funding and venture capital for technology and early-stage companies, through to public market financing for projects and mature companies. Investment categories are defined as follows:

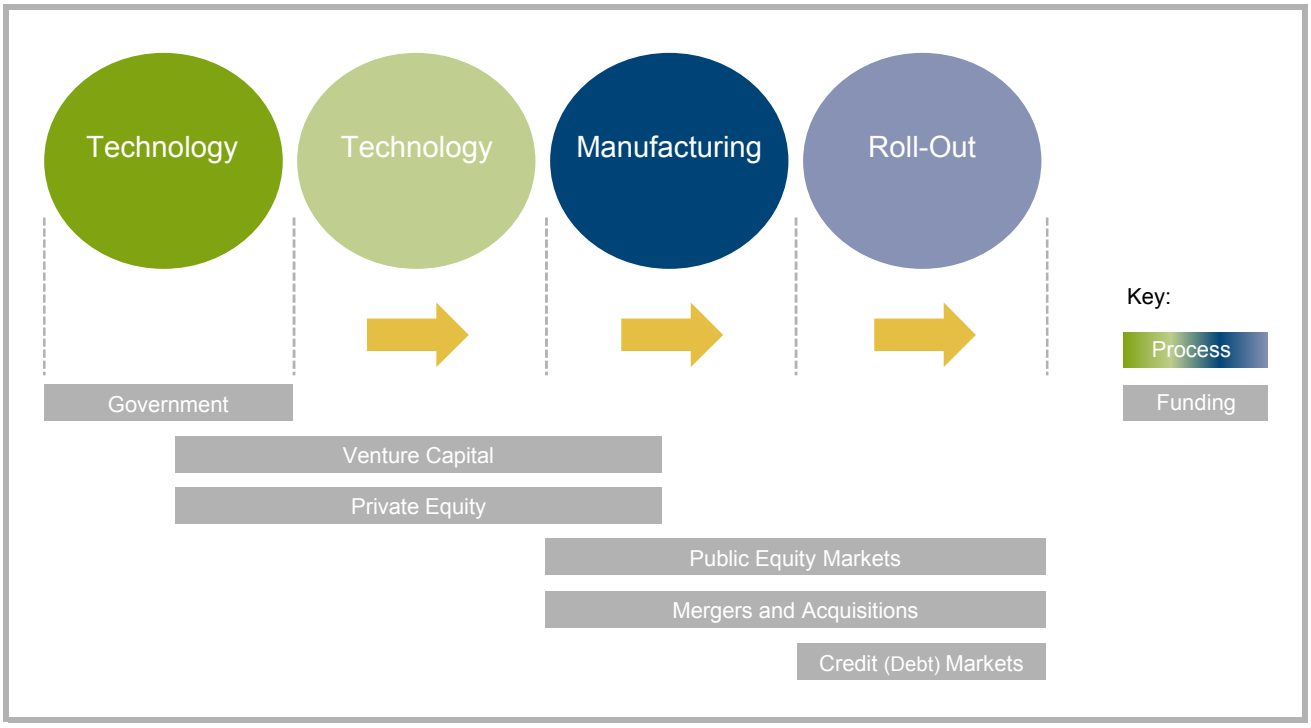
Venture capital and private equity (VC/PE): all money invested by venture capital and private equity funds in the equity of companies developing renewable energy technology. Similar investment in companies setting up generating capacity through special purpose vehicles is counted in the asset financing figure.

Public markets: all money invested in the equity of publicly quoted companies developing renewable energy technology and clean power generation.

Asset finance: all money invested in renewable energy generation projects, whether from internal company balance sheets, from loans, or from equity capital. This excludes refinancings.

Mergers and acquisitions (M&A): the value of existing equity and debt purchased by new corporate buyers, in companies developing renewable energy technology or operating renewable power and fuel projects.

REN21's **Renewables Global Status Report (GSR)**, first released in 2005, grew out of an effort to comprehensively capture the full status of renewable energy worldwide. Over the years, the GSR has expanded in scope and depth, in parallel with tremendous advances in renewable energy markets and industries. The report is a true collaborative effort of several authors, REN21 Secretariat staff and Steering Committee members, regional research partners, and more than 400 individual contributors and reviewers; and has become the most frequently referenced report on renewable energy business and policy, serving a wide range of audiences. The GSR is a sister publication to the Global Trends in Renewable Energy Investment (GTR) report, produced by the Frankfurt School-UNEP Collaborating Centre for Climate & Sustainable Energy Finance and Bloomberg New Energy Finance. The most recent edition of the report, launched in June 2012, is available at **www.ren21.net/gsr**



KEY FINDINGS

- Global investment in renewable power and fuels increased 17% to a new record of $257 billion in 2011. Developing economies made up 35% of this total investment, compared to 65% for developed economies.

- The US closed in on China in the race to be the lead investor in renewable energy, with a 57% leap in its outlays to $51 billion. India however displayed the fastest expansion rate for investment of any large renewables market in the world in 2011, with a 62% increase to $12 billion.

- One of the dominant features of the renewable energy landscape in 2011 was falling technology costs. Photovoltaic module prices fell by close to 50%, and onshore wind turbine prices by between 5% and 10%. These changes brought these two leading renewable power technologies closer to competitiveness with fossil-fuel alternatives such as coal and gas.

- The other key feature was a weakening in policy support for renewable energy in many developed countries. This reflected austerity pressures, particularly in Europe, and legislative deadlock in the US Congress.

- This policy hiatus, coming ironically at a time when fully competitive renewable power is starting to be a realistic possibility in a few years' time, is posing a threat to continued growth in investment in the sector in 2012 and beyond.

- That in turn puts into jeopardy hopes that investment in clean energy will reach sufficient levels to start to reduce global carbon emissions before 2020 – and provides a worrying backdrop for the coming Rio+20 United Nations Conference, which is largely focused on the "greening" of the global economy.

- There is, so far, no better example of economic "greening" than what has been achieved in the last seven years in the power sector. In 2011, renewable power (excluding large hydro) accounted for 44% of new generation capacity added worldwide, up from 34% in 2010 and just 10.3% back in 2004. The proportion of power generated by renewables (excluding large hydro) rose to 6% in 2011 from 5.1% the previous year.

- Total investment in solar power jumped 52% to $147 billion in 2011, reaching a figure almost twice as high as that in wind energy, at $84 billion, down 12%. Last year was not the first time that solar has led wind in terms of dollars committed, but it was the first time that the gap in favour of solar was anything apart from narrow.

- The performance of solar owed most to booming rooftop PV installations in Germany and Italy as property owners moved to take advantage of falling panel prices, and a spurt in the financing of large-scale solar thermal electricity generation (STEG, or CSP) projects in Spain and the US.

- Small-scale projects attracted $76 billion of investment worldwide in 2011, up a quarter from the $60 billion spent in 2010, despite rapidly falling prices for PV panels. Italy with $24.1 billion trumped Germany with $20 billion. Japan, the US, Australia, the UK and France also saw significant investment in small-scale PV.

- Share prices in the renewable energy sector had a dismal 2011, in the face of overcapacity in the solar and wind manufacturing chains and investor unease about the direction of support policies in both Europe and North America.

- The WilderHill New Energy Global Innovation Index, or NEX, slumped 40% during the year, while the Nasdaq and S&P500 ended the year almost exactly where they started. This severe under-performance by clean energy shares acted as a major dampener on public market financing of companies in the sector.

- The sovereign debt crisis in Europe in late 2011 hit the ability of banks to provide their usual flow of project finance. This increased the focus on possible, alternative sources of investment for renewable energy – such as pension funds and other long-term institutional investors.

- In early 2012, an $850 million bond issue for a PV project owned by Warren Buffett's MidAmerican Holdings underlined the potential of green bonds as an instrument for financing renewable power projects.

EXECUTIVE SUMMARY

Global investment in renewable power and fuels increased 17% to a new record of $257 billion in 2011. This was more than six times the figure for 2004, and 94% more than the total in 2007, the last year before the acute phase of the world financial crisis.

The percentage increase in investment between 2010 and 2011 was smaller than the 37% rise seen between 2009 and 2010, but it took place at a time when the cost of renewable power equipment, particularly solar photovoltaic modules and onshore wind turbines, was falling fast. The percentage growth in dollar investment would have been significantly larger in 2011 if it had not been for this deflation in the costs of PV and wind technology. The spectacular improvement in cost-competitiveness of renewables is explored in depth in Chapter 2. Last year's increase in investment in renewable energy also took place at a time of uncertainty over economic growth and policy priorities in developed economies – and those issues continue to pose a serious threat in 2012 to the low-carbon transition and hopes of progress towards a "green economy".

Two highlights of 2011 were the performance of solar, and the performance of the US. Wind is the most mature of the "new" renewable power technologies, and has usually been the biggest single sector for investment over recent years. However in 2011, it was out-stripped by solar, which attracted nearly twice as much investment – the first time a gap of anything like this magnitude has opened up for solar over wind.

Total investment in solar power jumped 52% to $147 billion. It was helped by booming rooftop photovoltaic installations in Germany and Italy, the spread of small-scale PV to other countries from China to the UK, and a spurt in the financing of large-scale solar thermal electricity generation (STEG, or CSP) projects in Spain and the US. By contrast, total investment in wind power slipped 12% to $84 billion, impacted by lower turbine prices, policy uncertainty in Europe and a slowdown in China's previously hectic growth in wind installations.

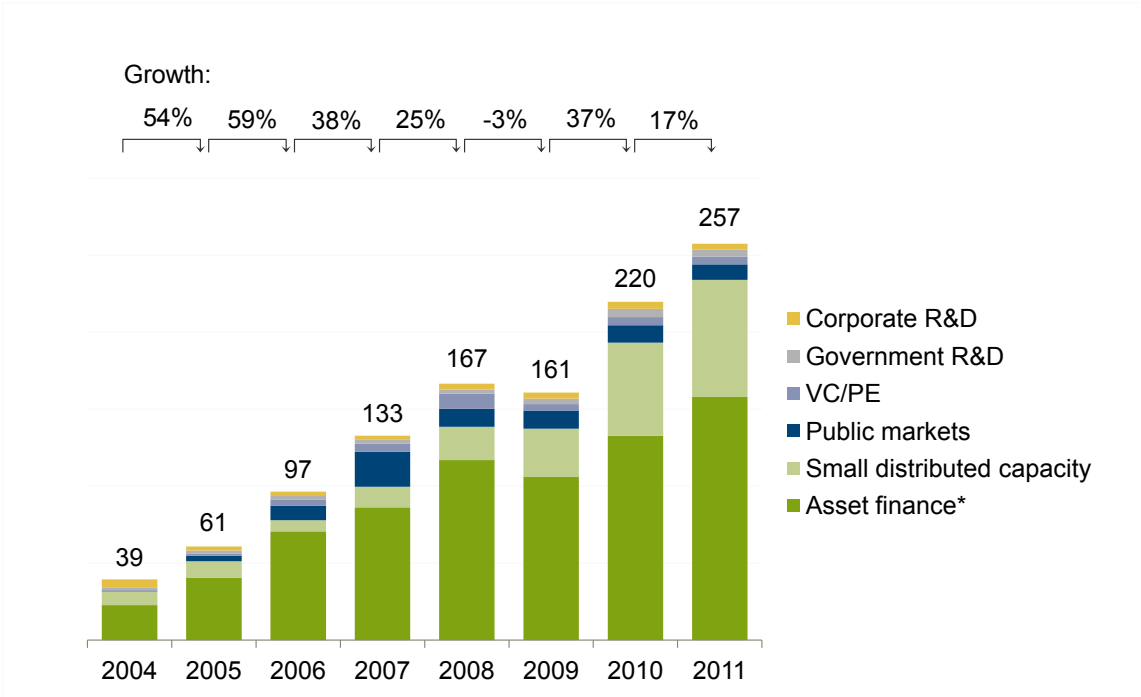
The boom in solar investment in 2011 took place against the backdrop of significant corporate distress in that sector, and tumbling share prices. The explanation for this apparent inconsistency between the year for companies and the year for solar as a whole was that prices of PV modules were falling rapidly thanks to economies of scale in manufacturing, the rise of low-cost Chinese

producers, and global over-capacity. The result – a near-50% fall in module prices during the year – stimulated demand for PV panels, particularly on rooftops, but it was also toxic for the financial results of many hardware makers. By the end of 2011, PV modules were selling in world markets for between $1 and $1.20 per Watt, some 76% below their prices just three and a half years earlier, in the summer of 2008.

The second highlight was a resurgence – at least temporarily – in the United States' importance in the renewable energy sector. Beaten into a distant second place by China in both 2009 and 2010, the US rallied to neck-and-neck with China in 2011, on the back of a 57% surge in US investment in renewables to $51 billion. Investment in renewable power and fuels in China gained a more modest 17% to $52 billion, still just a fraction ahead of the US (but actually behind the US if investment in energy-smart technologies such as efficiency and smart grids is also included). Investment in Germany – which pushed the US hard for second position in 2010 – dipped 12% to $31 billion[1].

The US bounce-back owed much to the fact that three significant incentive programmes for renewable energy either reached expiry during 2011, or headed towards scheduled expiry. In each case, developers rushed to finance projects in time to take advantage of the policy measure before it expired. The Federal loan guarantee programme, which reached "sunset" at the end of September 2011, covered $16.1 billion of debt for projects such as BrightSource's 392MW Ivanpah solar thermal project in southern California. The US Treasury grant programme, introduced to provide an alternative to the tax equity market, which had been hard hit by the financial crisis, came to an end on 31 December last year. The Production Tax Credit, the main support for US wind, is due to expire at the end of 2012, and with the two parties in Congress at loggerheads, few investors were confident that legislators would agree to extend it into 2013 and beyond.

FIGURE 1: GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY ASSET CLASS, 2004-2011, $BN



*Asset finance volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance

[1] The figure for Germany excludes corporate and government research and development.

Figure 1 shows the resilient growth of renewable energy investment since 2004, with expansion continuing through the recession of 2008-09 and the subsequent, disappointing recovery in developed economies. That growth has been accompanied by a significant rise in the job creation, and overall economic contribution, of the renewable energy sector – and that looks likely to continue to 2020 as the world seeks to curb emissions from its energy system. The importance of the "green economy" is explored in Chapter 3 of this report.

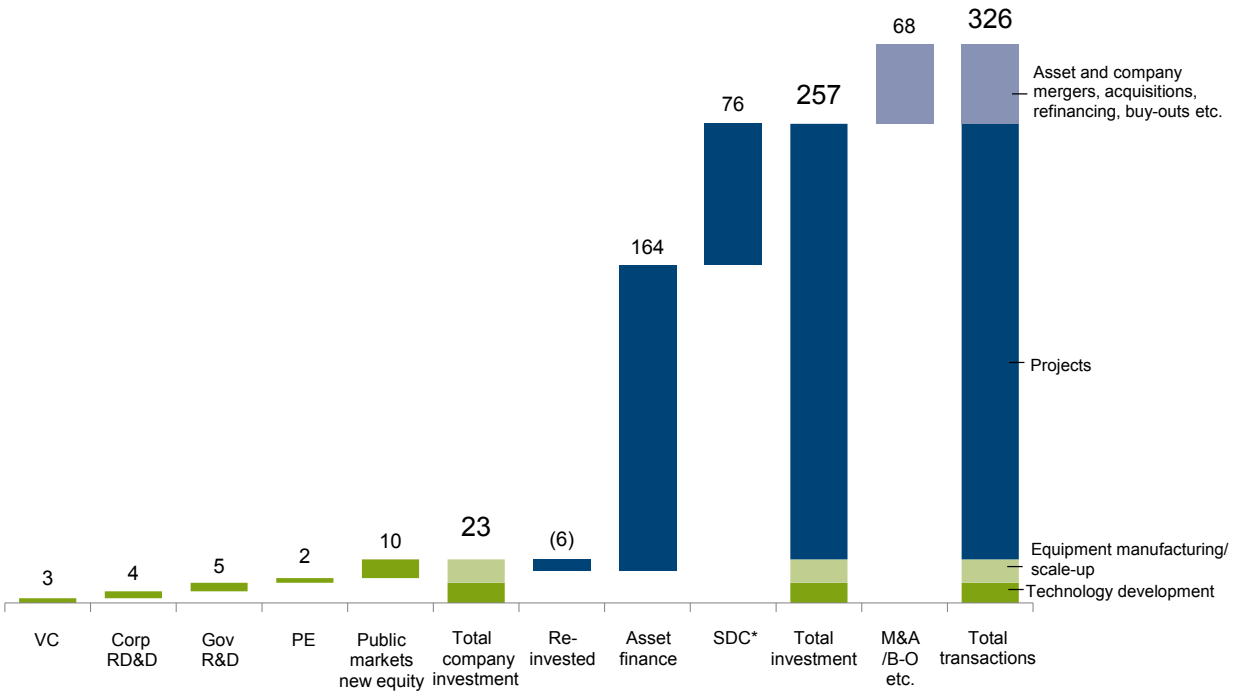
However one of the messages of this report is that while progress towards the expansion in renewable energy capacity was once again impressive in 2011, its smooth continuation in 2012, 2013 and after is not guaranteed. Risks of an interruption have increased. If a serious setback were to beset investment in renewables, the vision of a "green economy" to be discussed at the Rio+20 meeting on 20-22 June could recede into the distance.

THREATS TO INVESTMENT

Although the renewable energy sector has continued to grow, wider economic problems have had an impact since 2008, and they remain a threat. In late 2011, the euro area sovereign debt crisis started to impact the supply of debt for renewable energy projects in Europe, as banks responded to sharp increases in their cost of funding and upgraded their assessments of the risks involved in lending to borrowers in Italy, Spain and other affected countries.

More generally, the fact that consumers have found their finances under pressure has made governments more reluctant to wave through measures that would put up energy prices. In the US, support in Congress for clean energy and putting a price on carbon has ebbed, in the face of low natural gas prices that have made gas-fired generation look a cost-effective alternative, and new concerns about the cost of renewable energy support. The outlook for gas supply has changed

FIGURE 2: GLOBAL TRANSACTIONS IN RENEWABLE ENERGY, 2011, $BN



SDC = small distributed capacity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

dramatically, with the technological advances in "fracking". Complaints about the cost of subsidies for renewables gathered strength after the scandal over the bankruptcy of PV technology company Solyndra, which received $538 million of Federal loan guarantees.

In Europe, governments struggled to adjust feed-in tariff subsidies for solar power quickly enough – in the face of rapid reductions in the cost of the technology. These cost reductions resulted in greater-than-intended returns for PV project developers, and booms in installation, especially in Italy and Germany, both of which saw more than 7GW installed in 2011. Inevitably, governments in Europe and elsewhere have responded by cutting subsidies sharply – and in the case of Spain, barring subsidies for any new renewable power project not so far approved.

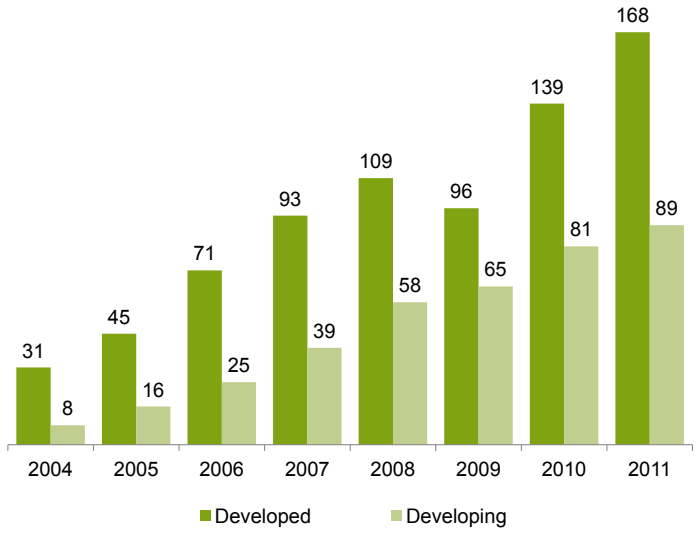
FIGURE 3: SEFI GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2011 DATA TABLE, $BN

Category / Year / Unit	2004 $bn	2005 $bn	2006 $bn	2007 $bn	2008 $bn	2009 $bn	2010 $bn	2011 $bn	2010-11 Growth %	2004-11 CAGR %
1 Total Investment										
1.1 New investment	39.5	60.8	96.5	132.8	166.6	160.9	219.8	257.5	17%	31%
1.2 Total transactions	48.6	85.2	132.2	191.9	231.2	226.1	285.1	325.9	14%	31%
2 New Investment by Value Chain										
2.1 Technology development										
2.1.1 Venture capital	0.4	0.6	1.2	2.1	3.0	1.5	2.4	2.5	5%	30%
2.1.2 Government R&D	1.9	2.0	2.2	2.5	2.6	3.5	5.3	4.6	-13%	14%
2.1.3 Corporate RD&D	5.1	2.5	2.9	2.7	3.9	4.0	4.6	3.7	-19%	-5%
2.2 Equipment Manufacturing										
2.2.1 Private equity expansion capital	0.3	1.0	3.0	3.2	6.9	2.8	2.9	2.5	-15%	33%
2.2.2 Public markets	0.3	3.5	9.4	22.7	11.6	11.7	11.3	10.1	-10%	69%
2.3 Projects										
2.3.1 Asset finance	22.8	40.5	71.7	92.0	121.5	108.6	138.8	164.4	18%	33%
Of which re-invested equity	0.0	0.0	1.1	5.7	4.5	2.4	6.0	6.1	3%	-
2.3.3 Small distributed capacity	8.6	10.8	7.2	13.4	21.6	31.2	60.4	75.8	25%	36%
Total Financial Investment	23.8	45.5	84.3	114.2	138.5	122.2	149.5	173.4	16%	33%
Gov't R&D, corporate RD&D, small projects	15.6	15.3	12.2	18.5	28.1	38.7	70.3	84.1	20%	27%
Total New Investment	39.5	60.8	96.5	132.8	166.6	160.9	219.8	257.5	17%	31%
3 M&A Transactions										
3.1 Private equity buy-outs	0.9	3.8	1.7	3.6	5.6	2.6	1.9	3.4	77%	21%
3.2 Public markets investor exits	0.0	1.3	2.7	4.3	1.2	2.6	5.3	0.2	-97%	-
3.3 Corporate M&A	2.6	6.9	12.9	20.2	18.7	21.7	21.1	28.4	34%	40%
3.4 Project acquistion & refinancing	5.5	12.3	18.5	31.0	39.0	38.3	37.0	36.5	-1%	31%
4 New Investment by Sector										
4.1 Wind	13.3	22.9	32.0	51.1	67.7	74.6	95.5	83.8	-12%	30%
4.2 Solar	13.8	16.4	19.5	37.7	57.4	58.0	96.9	147.4	52%	40%
4.3 Biofuels	3.5	8.2	26.6	24.5	19.2	9.1	8.5	6.8	-20%	10%
4.4 Biomass & w-t-e	6.1	7.8	10.8	11.8	13.6	12.2	12.0	10.6	-12%	8%
4.5 Small hydro	1.4	4.4	5.4	5.5	6.6	4.7	3.6	5.8	59%	22%
4.6 Geothermal	1.4	1.0	1.4	1.4	1.9	2.0	3.1	2.9	-5%	12%
4.7 Marine	0.0	0.0	0.9	0.7	0.2	0.3	0.3	0.2	-5%	30%
Total	39.5	60.8	96.5	132.8	166.6	160.9	219.8	257.5	17%	31%
5 New Investment by Geography										
5.1 United States	7.4	11.2	27.2	28.5	37.7	22.5	32.5	50.8	57%	32%
5.2 Brazil	0.4	1.9	4.3	9.3	12.7	7.3	6.9	7.5	8%	51%
5.3 AMER (excl. US & Brazil)	1.3	3.3	3.3	4.7	5.4	6.4	11.0	7.0	-36%	27%
5.4 Europe	18.6	27.7	37.4	57.8	67.1	67.9	92.3	101.0	10%	27%
5.5 Middle East & Africa	0.3	0.4	1.6	1.9	3.7	3.1	6.7	5.5	-18%	50%
5.6 China	2.2	5.4	10.0	14.9	24.3	37.4	44.5	52.2	17%	57%
5.7 India	2.0	2.9	4.7	5.6	4.7	4.2	7.6	12.3	62%	29%
5.8 ASOC excl. (China & India)	7.2	8.0	8.0	10.1	11.0	12.1	18.4	21.1	15%	17%
Total	39.5	60.8	96.5	132.8	166.6	160.9	219.8	257.5	17%	31%

New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

FIGURE 4: GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY: DEVELOPED V DEVELOPING COUNTRIES, 2004-2011, $BN

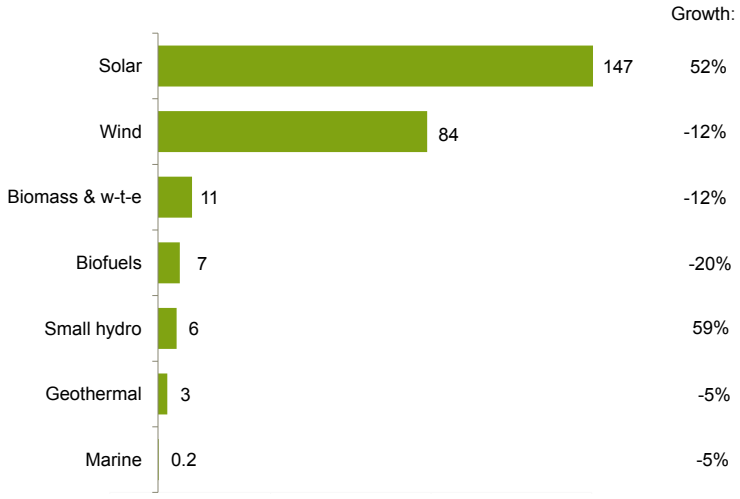


New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance

With PV solar and onshore wind equipment prices falling rapidly, there is a "promised land" in sight in which these technologies will not require any subsidy. Rooftop solar is already competitive with retail electricity in a number of locations, and Bloomberg New Energy Finance estimates that the average onshore wind project will be competitive with gas-fired generation by 2016.

FIGURE 5: GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2011, AND GROWTH ON 2010, $BN



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

The danger however is that hastily-made cuts in support might make a serious dent in investment in developed economies in 2012-14 – before wind and solar can reach that goal of competitiveness. That would be a damaging blow not just for businesses in those industries but also for hope of limiting carbon emissions and climate change, and for those working in the emerging "green economy".

$257 BILLION INVESTMENT

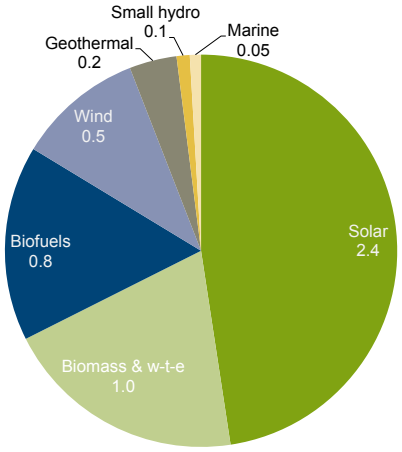
Figure 2 shows the make-up of that record $257 billion investment total in 2011, while Figure 3 shows the sector and geographic detail, and the changes over time.

Different types of investment displayed very different fortunes during the year – venture capital investment, for instance, rose 5% to $2.5 billion, but government-funded and corporate research and development both fell back. Government R&D slipped 13% to $4.6 billion as the effect of "green stimulus" packages faded; corporate R&D weakened 19% to $3.7 billion as companies responded to pressure on their own finances.

Private equity expansion capital investment dropped 15% to $2.5 billion. Equity-raising by renewable energy companies on the public markets also fell back last year, down 10% to $10.1 billion, as investors shied away from a sector that was suffering heavy share price falls.

The two types of new investment that did see significant growth in 2011 were asset finance of utility-scale (1MW-plus) renewable power plants and biofuel refineries; and small-scale distributed capacity, notably rooftop solar. Asset finance was up 18% to $164.4 billion, while small-scale projects saw $75.8 billion invested,

FIGURE 6: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2011, $BN



VC/PE new investment excludes PE buy-outs. Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

up 25% on the previous year. Both were record figures.

One other type of financial transaction is also captured in Figures 2 and 3, although it is not counted as new investment – and that is merger and acquisition activity. This totalled $68.4 billion in 2011, up 5% on the previous year. Within M&A, corporate acquisitions were up 34% at a record $28.4 billion, as buyers took advantage of lower valuations for target companies. Project acquisitions and refinancings were down 1% at $36.5 billion.

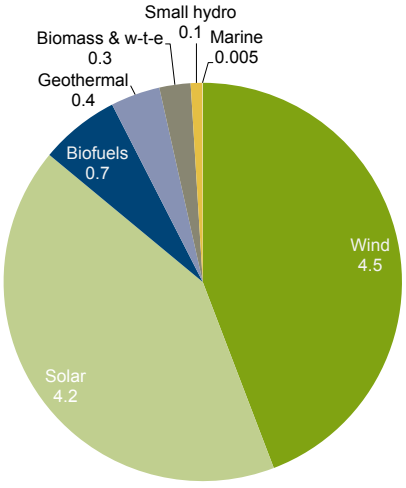
Investment increased in both developed and developing countries in 2011 (see Figure 4)[2]. It rose in developed economies by 21% to $168 billion, and in developing economies by 11% to $89 billion. In asset finance of utility-scale projects, developing countries out-invested developed economies in 2010, by $70 billion to $69 billion, but this was reversed in 2011, with developed economies investing $86 billion and developing countries $79 billion.

The breakdown by sector of types of new investment (ie not including M&A) is shown in Figures 5 to 8. Although 2011 overall was dominated by solar's record year and a setback for wind (in terms of dollar investment), there were intriguing changes at a more detailed level, and among the other technologies.

As Figure 5 shows, biomass and waste-to-power was the third largest sector for total renewable energy investment last year, even though its share fell 12% to $10.6 billion. Biofuels, which was the second-largest sector for investment after wind in 2006, came fourth in 2011 with a total of $6.8 billion. This was down 20% on 2010 but there were signs, in the financing by venture capital, private equity and public market investors of companies producing second-generation biofuel (not based on food oils or grains), of a warming in sentiment towards this sector after some tough years.

Other renewable energy sectors showed more modest investment – small hydropower projects of less than 50MW[3], and the companies involved in them, attracted 59% more capital last year, taking their tally to $5.8 billion; geothermal investment was down 5% at $2.9 billion; and wave and tidal was

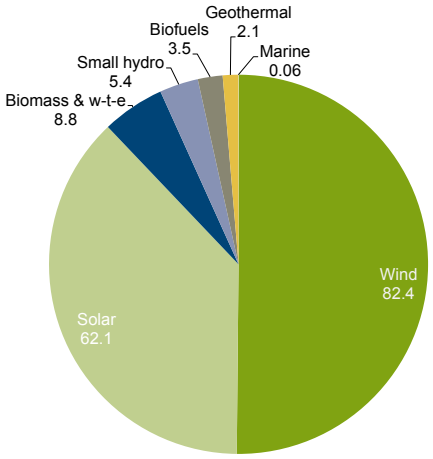
FIGURE 7: PUBLIC MARKETS NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2011, $BN



Source: Bloomberg New Energy Finance, UNEP

[2] Developed countries are defined as OECD members excluding Mexico, Chile and Turkey.
[3] Hydropower projects of more than 50MW are not within the main scope of this report. However there is a box on large hydro-electric in Chapter 4.

FIGURE 8: ASSET FINANCE OF RENEWABLE ENERGY ASSETS BY SECTOR, 2011, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

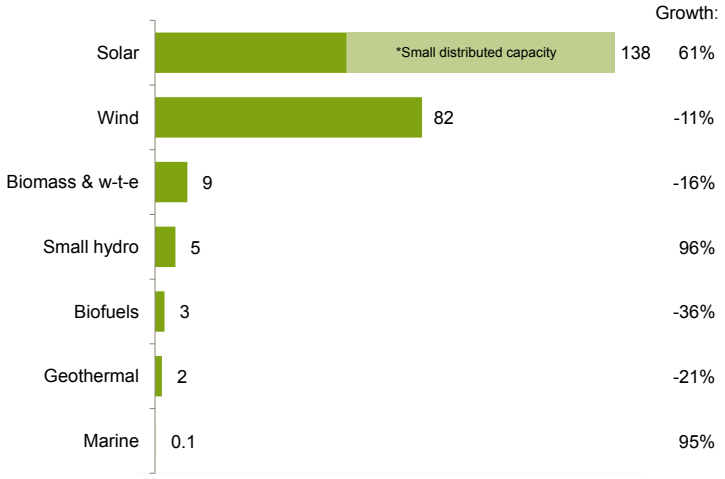
down 5% at just $246 million. A large (254MW) South Korean tidal barrage project started full operations in 2011, but it had been financed several years earlier.

Solar was the leading sector in venture capital and private equity provision of renewable energy, with $2.4 billion (see Figure 6). As a relatively mature technology, wind has tended to lag behind in terms of VC/PE investment, and in 2011 it came fourth with just $520 million committed, down 66%. Ahead of it were biomass and waste-to-power, with $1 billion of VC/PE money secured, nearly three times the previous figure, and biofuels with $804 million secured, up 9%.

Moving onto public markets investment (Figure 7), wind and solar vied for first place in terms of the value of new equity-raisings, at $4.5 billion and $4.2 billion respectively, down 2% and 23% on their 2010 totals. Biofuels and geothermal obtained $654 million and $406 million respectively, up 37% and 360%.

In asset finance of utility-scale projects (Figure 8), wind retained a lead over solar, with $82.4 billion committed, down 11%, against the latter's $62.1 billion, but the latter was up no less than 147% compared to 2010. Looking one level of detail further down, the major renewable power sources showed some interesting technological trends. The two have historically been dominated by onshore wind and PV respectively, but last year offshore wind loomed large and contributed $12.5 billion to the total value of wind assets financed, while solar thermal accounted for $20 billion of the total solar figure – in both cases, the highest on record.

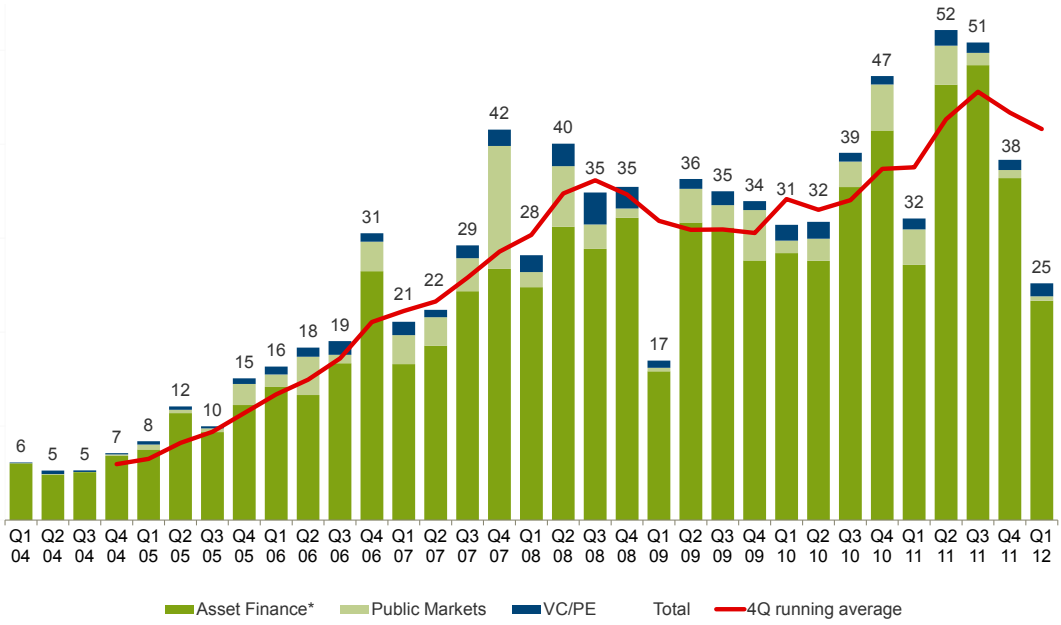
FIGURE 9: ASSET FINANCE OF RENEWABLE ENERGY ASSETS AND SMALL DISTRIBUTED CAPACITY BY SECTOR, 2011, AND GROWTH ON 2010, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance

Total capacity investment is shown in Figure 9. This brings together small-scale projects with the utility-scale developments. On this measure, solar dominated in 2011, with $137.8 billion invested, up 61% on 2010 – thanks in greatest part to the expansion of rooftop PV in Europe and elsewhere. On the total capacity investment measure, wind was the second-largest sector with $82.4 billion, biomass and waste-to-power third with $8.8 billion (down 16%), small hydro fourth with $5.4 billion, and biofuels fifth with $3.5 billion (down 36%).

FIGURE 10: VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY QUARTERLY TREND, Q1 2004-Q1 2012, $BN



*Asset finance volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

INVESTMENT IN 2012

Investment in renewable energy was subdued in the first three months of 2012, in the face of uncertainty over future policy support in Europe and the US. Although there were, by May, a few signs that governments were trying to clarify specific issues for investors, there was not yet any evidence that investment levels would accelerate in the rest of the year.

Figures from the Bloomberg New Energy Finance database of deals and projects show that asset finance of utility-scale renewable energy projects in Q1 2012 was $23.3 billion (after adjusting for reinvested equity), down 36% from the fourth quarter of 2011 and 14% below the figure for the first quarter of last year (see Figure 10).

In fact, Q1 2012 was the weakest quarter for renewable energy asset finance since the first quarter of 2009, in the depths of the financial crisis. There were still some big projects financed however – including the 396MW Marena Wind Portfolio in Mexico for $961 million, the 100MW KVK Chinnu solar thermal plant in India for approximately $400 million, and the 201MW Post Rock Wind farm in Kansas, US, for an estimated $376 million.

The largest projects financed in Europe in Q1 – in the face of a difficult market for bank lending – were the 150MW Monsson Pantelina wind farm in Romania at $317 million, and the 60.4MW SunEdison Karadzhalovo solar PV plant in Bulgaria at $248 million.

Venture capital and private equity investment in renewable energy companies was resilient, at $1.4 billion worldwide in Q1, up from $1.1 billion in Q4 and $1.2 billion in the equivalent quarter of 2011. Solar and biofuels were the two dominant sectors for VC/PE equity-raisings.

Public markets investment was just $473 million, down 46% from Q4 and 87% from Q1 2011. This was not surprising given the poor performance of clean energy shares over the last few quarters. The WilderHill New Energy Global Innovation Index, or NEX, which tracks the movements of 98 clean energy shares worldwide, fell 40% in 2011 and clawed back just 7% in the first quarter of 2012 as world stock markets rebounded.

INVESTMENT BY TYPE OF ECONOMY

- Developed economies strengthened their share of investment in renewable power and fuels in 2011. Developing countries achieved their highest share so far recorded back in 2009.
- However a look at the country breakdown shows that the performance of developed economies owed a great deal to a jump in US asset finance and a boom in small-scale PV in Italy and Germany – both developments spurred on by the impending expiry of subsidy programmes.
- Total investment in the US raced ahead by 57% in 2011. That in Italy (excluding research and development) rose by 43%, and although Germany's fell by 12%, it still remained the third biggest market worldwide for renewable energy investment.
- Meanwhile, among developing economies, the growth of renewable energy investment in China slowed sharply in 2011. It was India that displayed the fastest expansion in investment of any large renewables market in the world, with growth of 62%.
- Total investment in the Middle East and Africa region fell by 18%, confounding hopes at the start of the year that 2011 might see a surge in activity. Policy uncertainty created by the Arab Spring delayed some projects, but a number of important initiatives did still progress.

DEVELOPED VERSUS DEVELOPING COUNTRIES

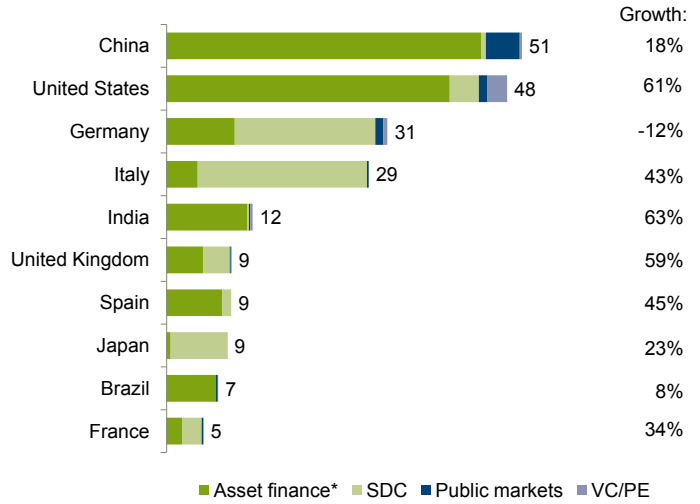
In 2011, the share of total investment worldwide accounted for by developing countries slipped back to 35%, from 37% in 2010 and 40% in 2009. As noted in the Executive Summary, developing countries took the lead in terms of investment in utility-scale asset finance for the first time in 2010. But developed countries jumped back into the lead in this key area of investment in 2011 and retained a huge lead in another important area, small-scale distributed capacity.

This fight-back by the richer countries could prove to be a temporary phenomenon, because much of it was brought about by the impending expiry of subsidy schemes in the US, Germany and Italy. When the last projects qualifying for those subsidies have closed their financings – at different times this year for the three countries – there could be a sharp fall-off in asset finance and small-scale capacity investment in those jurisdictions. Between them, in 2011 the US, Germany and Italy accounted for around four-fifths of outlays by all developed economies.

Figure 3 in the Executive Summary shows that for total investment, China came top of the tree in 2011, with $52 billion, a hair's breadth ahead of the US with $51 billion. Whereas the growth rate for Chinese investment was 17% last year, it was 57% for the US. Behind that contrast were a slowing in China's wind project development after years of frenzied growth, and a spurt in US wind and solar financings ahead of the expiries of the Federal loan guarantee programme in September 2011, the Treasury grant programme in December 2011 and the scheduled expiry of the Production Tax Credit in December 2012.

India enjoyed the sharpest growth in total investment, at 62% to $12 billion, while Brazil managed more moderate growth of 8% to $7 billion. The Indian advance reflected a sharp

FIGURE 11: NEW INVESTMENT IN RENEWABLE ENERGY BY COUNTRY AND ASSET CLASS, 2011, AND GROWTH ON 2010, $BN



Top 10 countries. *Asset finance volume adjusts for re-invested equity. Excludes corporate and government R&D

Source: Bloomberg New Energy Finance, UNEP

increase in the financing of solar projects under the country's National Solar Mission, and rises in wind capacity addition and venture capital and private equity investment in renewable energy companies. Brazil's progress came not primarily because of ethanol, its dominant renewable energy sector in the first decade of the century, but because of wind (see below).

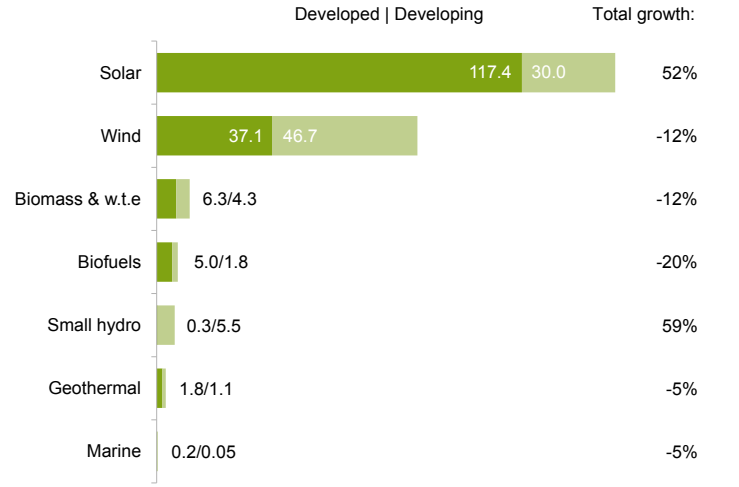
Figure 11 shows the country comparison excluding research and development. The reason for displaying this is that government and corporate R&D are difficult to split out completely between individual European nations. On the basis of the Figure 11 measure, China still led the US (by a slightly larger margin because America's higher R&D spending is left out), Germany comes third with investment of $31 billion, Italy fourth with $29 billion, and India fifth. The UK, Spain, Japan, Brazil and France made up the rest of the top 10.

Developed countries led the way in solar, while developing economies had the upper hand in wind, as Figure 12 reveals. Developed countries' $117.4 billion of investment in solar owed much to large solar thermal electricity generation financings in the US and Spain, and to the small-scale rooftop PV booms in Germany and Italy. China was again the dominant market in the world for wind farm outlays.

Figures 13 and 14 provide comparisons of investment activity by region. In Figure 13, Europe is clearly the biggest area for dollars deployed, at $101 billion in 2011. The striking messages from these charts include the bumpy progress of the US, the slowing growth rate of Europe (in dollar terms), and the rapidly gathering pace in India and the rest of Asia-Oceania excluding China.

Figures 15 and 16 show the national comparisons in the second-largest element of investment - small-scale distributed projects - and in the largest, asset finance of utility-scale projects. In small-scale, the dominant two countries by far were Italy and Germany, at $24.1 billion and $20 billion respectively, both

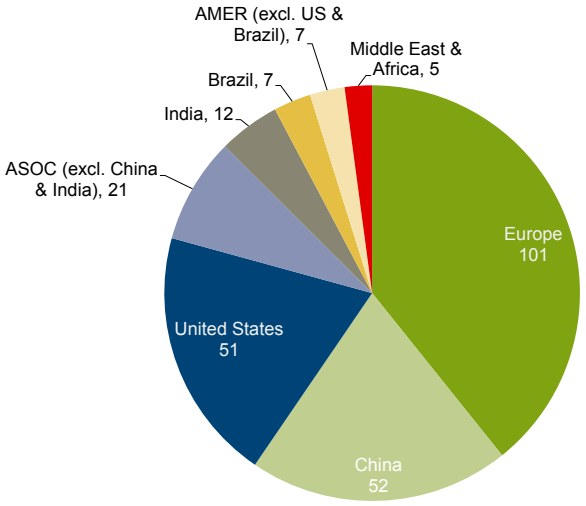
FIGURE 12: GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY: DEVELOPED V DEVELOPING COUNTRIES, 2011, AND TOTAL GROWTH ON 2010, $BN



Total values include estimates for undisclosed deals. New investment volume adjusts for re-invested equity. Includes estimates for small distributed capacity, corporate and government R&D.

Source: Bloomberg New Energy Finance, UNEP

FIGURE 13: GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2011, $BN



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

seeing booms in PV development in response to generous but about-to-expire feed-in tariffs. They were followed by Japan in a strong third position with $8.1 billion, and then by the US and by other European countries.

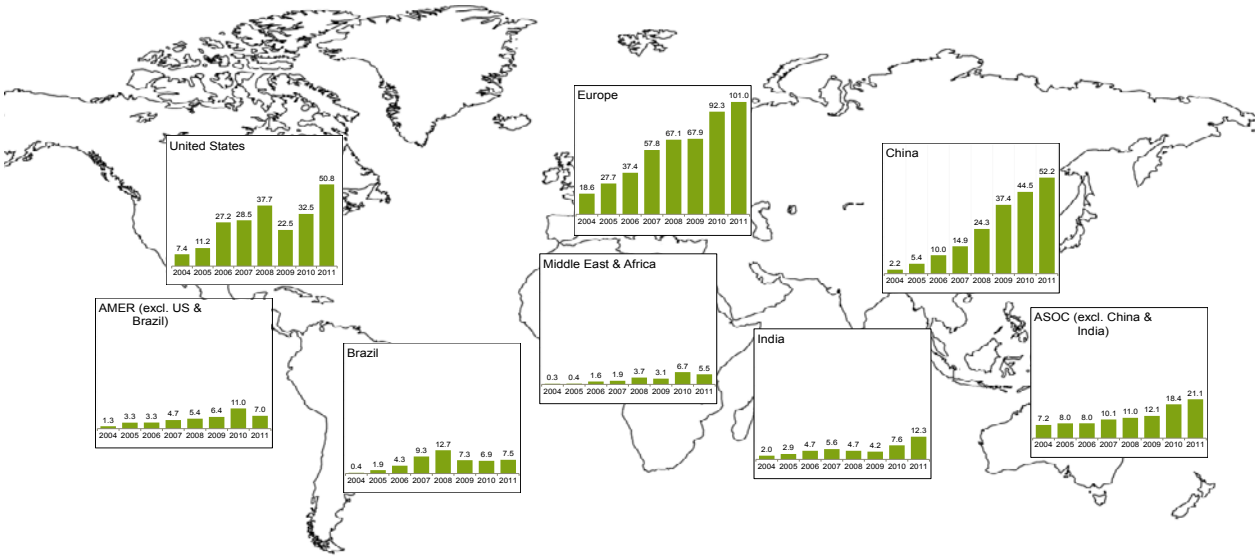
In asset finance, there was a very different pecking order. China was first with $49.7 billion, followed by the US on $40.9 billion. Distant third and fourth were India on $11.6 billion, and Germany on $9.7 billion, followed by Spain and Brazil. The sections that follow look at these individual country results in more detail.

CHINA, INDIA AND BRAZIL

China was once again by far the heaviest investor of the three developing economy giants. Figure 17 shows the split of asset-finance, public markets and venture capital and private equity investment in China between five leading renewable energy sectors - wind, solar, small hydro, biomass and biofuels - adjusted for reinvested equity.

Asset finance of wind projects totalled $28.2 billion, down 7%, while that of solar projects jumped 273% to $11.4 billion. The big financings of the year included $909 million for the 300MW Laoting Putidao offshore wind project, developed by Hebei Construction, and $478 million for the 100MW Geermu solar thermal plant being

FIGURE 14: GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2011, $BN



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

FIGURE 15: SMALL DISTRIBUTED CAPACITY INVESTMENT BY COUNTRY, 2011, AND GROWTH ON 2010, $BN

	2011	% growth on 2010
China	0.7	14%
Greece	0.8	405%
Spain	1.3	44%
France	2.7	99%
United Kingdom	3.8	1621%
Australia	3.8	105%
United States	4.2	5%
Japan	8.1	25%
Germany	20.0	-20%
Italy	24.1	76%

Top 10 countries. Represents investments in solar PV projects with capacities below 1MW.

Source: Bloomberg New Energy Finance, UNEP

FIGURE 16: ASSET FINANCE OF RENEWABLE ENERGY ASSETS BY COUNTRY, 2011, AND GROWTH ON 2010, $BN

Units: $bn	2011	% growth on 2010
Denmark	2.4	5627%
Canada	4.1	-13%
Italy	4.5	-31%
United Kingdom	5.2	7%
Brazil	7.3	13%
Spain	7.9	46%
Germany	9.7	-4%
India	11.6	74%
United States	40.9	96%
China	49.7	20%

Top 10 countries. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

FIGURE 17: VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN CHINA BY SECTOR, 2011, $BN

	Asset finance*	Public markets	VC/PE	Total
Wind	28.2	3.2	-	31.4
Solar	11.4	1.6	0.3	13.3
Small hydro	2.9	-	-	2.9
Biomass & w-t-e	2.1	-	0.001	2.1
Biofuels	0.2	-	-	0.2

*Asset finance volume adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

developed by China Power Investment Corporation.

Nearly 20GW of wind capacity was added in China in 2011, up from 17GW in 2010. The 2011 figure put it well ahead of any other country in the world for the third year running. Installation is expected to continue at a high rate for the next few years, but 2011 may turn out to have been the peak. One continuing problem for onshore wind in China is grid connection, with about a quarter of the 2011 projects still not connected by the end of the year. The offshore wind market is getting going, with a round of projects auctioned in 2010 and another due this year, but it will be 2014 or later before the amount of capacity added exceeds 1GW.

The jump in solar asset finance reflected a record 2.2GW of PV capacity commissioned in the year, and also activity in solar thermal electricity generation. Asset finance of small hydro in China jumped sharply to $2.9 billion in 2011[4], while, in biomass and waste-to-power, it fell 40% to $2.1 billion in 2011, and in biofuels it edged up to $177 million from less than $100 million the year before.

Other types of financial investment were more subdued in China in 2011. Venture capital and private equity investment in companies continued to be extremely low, while public markets investment was at $4.8 billion in total, down 5% on 2010 levels. This decline was relatively modest, given the sharp slide in clean energy share prices during the year (see Chapter 6 for further details), and the disorderly falls in PV and onshore wind equipment prices. Turbine maker Sinovel Wind Group raised $1.4 billion via an initial public offering in Shanghai, and Huaneng Renewables Corporation, the wind project development arm of a

[4] There is some uncertainty over the size of Chinese small hydro capacity additions last year, with at least one government statement citing a large figure. In this report, we have maintained a conservative approach towards announced capacity additions that have not yet been confirmed by bottom-up data on projects.

FIGURE 18: VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN INDIA BY SECTOR, 2011, $BN

	Asset finance*	Public markets	VC/PE	Total
Wind	5.5	0.2	0.2	5.9
Solar	4.6	-	0.1	4.7
Biomass & w-t-e	0.9	-	0.03	0.9
Small hydro	0.5	-	0.03	0.5
Marine	0.01	-	-	0.01
Biofuels	0.001	-	-	0.001

*Asset finance volume adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

Chinese power company, raised $850 million via an IPO in Hong Kong.

India saw a more spectacular rate of increase in clean energy investment in 2011. Figure 18 displays the split between different categories of outlay, with asset finance by far the dominant component, and wind and solar the leading sectors within that.

The growth was not mainly due to asset finance in wind, which was $5.5 billion after adjusting for reinvested equity, up just 5% from 2010 levels. Asset finance in solar however was up from $426 million to $4.6 billion, or nearly tenfold. Biomass and waste-to-power asset finance in India rose 45% to $857 million last year, while that for small hydro trebled to $510 million.

The jump in solar asset investment in India was partly driven by the Jawaharlal Nehru National Solar Mission, a programme that aims to aid the development of 20GW of solar power by 2022. The Ministry of New and Renewable Energy provides feed-in tariffs to form the basis of power purchase agreements with the state-owned power producer NTPC. One of the biggest projects financed in 2011 was the 125MW Sakri PV portfolio by Maharashtra State Power Generation Company, for $527 million.

Public markets investment in clean energy companies in India fell steeply from $716 million in 2010 to just $189 million in 2011, a casualty of the world stock market downturn for shares in the sector. The main deal in the year was a convertible share issue by turbine maker Suzlon Wind Energy.

Brazil has seen a major shift in sector momentum over recent years, with biofuels dominant in the 2006-08 period but then running out of steam as the market struggled to absorb the new capacity built – and then wind expanding rapidly in more recent times. Overall asset finance in Brazil, after accounting for reinvested equity, reached $11.6 billion in 2008 as the biofuel boom peaked, then fell to $6.6 billion in 2009 and $6.2 billion in 2010, before recovering to $7 billion in 2011.

Figure 19 shows that wind accounted for $4.7 billion of this, and small hydro $947 million. Biofuels were at $939 million, and biomass and waste-to-energy at $450 million. The wind figure was up 144% on the previous year, with small hydro up 3%, biofuels down 56% and biomass down 61%. The performance by wind reflected a realisation by investors that, given the recent falls in turbine prices and Brazil's natural resource in wind, it was possible to bid low at national power auctions. Brazil now has a pipeline of 6.6GW of wind projects waiting to be developed between 2012 and 2016.

Energy auctions in Brazil last year

FIGURE 19: VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN BRAZIL BY SECTOR, 2011, $BN

	Asset finance*	Public markets	VC/PE	Total
Wind	4.7	0.3	0.03	5.0
Small hydro	0.9	-	-	0.9
Biofuels	0.9	-	-	0.9
Biomass & w-t-e	0.5	-	-	0.5
Solar	0.01	-	0.02	0.03

*Asset finance volume adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

showed particularly strong bidding by wind developers. In the 20 December one, for instance, wind won 976MW of the 1.2GW of renewable energy capacity contracted. In the August auction, wind out-bid gas-fired projects and took nearly half of the 3.9GW capacity awarded. The latter episode saw the lowest market-wide tariff for wind globally, at BRL 99 ($62) per MWh.

Eletrosul, a subsidiary of Brazilian state-owned utility Eletrobras, won the largest share (a quarter) of total contracted capacity in the summer 2011 auctions via participation in two joint ventures. An Eletrosul-led consortium with local private-equity firm Rio Bravo and local pension fund Fundação ELOS secured contracts for their 90MW Cerro Chato complex in Rio Grande do Sul state. A separate Eletrosul-Rio Bravo JV secured contracts for the 109MW Verace, 98MW Chui, and 46MW Minuano wind projects - all located in Rio Grande do Sul state.

Other types of renewable energy investment in Brazil in 2011 were subdued, although public market equity issuance was more than double the previous year's paltry figure at $250 million.

DEVELOPED ECONOMIES

As in 2010, the US was the biggest investor in renewable energy among individual developed countries. It almost supplanted China for the overall number one spot for investing in renewable

energy – and indeed it did on the slightly wider measure, of clean energy investment including energy-smart technologies. The largest part of the US outlay on renewable energy in 2011 was asset finance of utility-scale projects, at $40.3 billion, up an eye-catching 95%, with small distributed capacity at $4.2 billion, up 6%, and venture capital and private equity investment at $2.8 billion, down 11%. Public markets investment, at $1.2 billion, was down a savage 48% - hit by the bear market in clean energy stocks.

Figure 20 shows the detail for three different types of investment in the US in the year. Asset finance was dominated by solar, at $25.3 billion – reflecting big financings assisted by soon-to-expire government support programmes. Among the big financings were NRG Energy's Project Amp PV plant, at $2.5 billion for 752MW, First Solar's Desert Sunlight PV plant, $2.3 billion for 550MW, and BrightSource's Ivanpah solar thermal portfolio, $2.2 billion for 392MW.

Wind contributed a mere $11.3 billion to US asset finance last year, down from $16.4 billion in 2010 and well below the record $18.1 billion achieved in 2008. Wind financings were affected by the low natural gas price, which made attractive power purchase agreements difficult to negotiate for wind project developers. One of the biggest wind asset financings of the year was the BP Flat Ridge Wind Farm Phase 2 in Kansas, at $800 million for 419MW.

FIGURE 20: VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN THE US BY SECTOR, 2011, $BN

Units: $bn	Asset finance*	Public markets	VC/PE	Total
Solar	25.3	0.6	1.71	27.6
Wind	11.3	0.0	0.2	11.5
Biofuels	1.8	0.6	0.67	3.1
Biomass & w-t-e	1.2	-	0.2	1.4
Geothermal	0.5	0.10	0.11	0.6
Small hydro	0.1	-	0.01	0.1
Marine	-	-	0.002	0.002

*Asset finance volume adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

Biofuels asset finance in the US was $1.8 billion in 2011, but this was actually up 27-fold on the 2010 total and was the highest annual figure since 2008. It was still far below the $12.2 billion record chalked up in 2006, at the peak of the corn ethanol boom.

Venture capital and private equity investment in the US renewable energy sector in 2011 was relatively subdued at $2.8 billion in 2011, compared to the record $5.3 billion attained in 2008, although it was closer to the 2010 total. Solar was, once again, the sector taking the most VC/PE equity during the year, at $1.7 billion, with biofuels (the second-generation or cellulosic version) in second place with $669 million.

Figure 21 shows how Italy performed in terms of three types of investment in 2011. Asset finance, public markets and venture capital/private equity investment added up to $4.7 billion, down 26% compared to 2010, due to lower figures for wind and solar asset finance. In 2011, solar was the leading sector in terms of utility-scale asset finance, at $3.7 billion, although this was a modest figure compared to the amount the country invested in small-scale projects, at $24.1 billion (see Figure 15). Small-scale PV boomed thanks to a generous feed-in tariff available under the fourth Conto Energia scheme. Wind farm development in Italy struggled in the face of uncertainty over the future price of green certificates.

Bloomberg New Energy Finance's estimates are that 7.9GW of PV (large-scale and small-scale) were completed in Italy in 2011, putting it ahead of Germany's 7.5GW. Other strong European markets for solar were France, at 1.6GW installed, and the UK, at about 1.15GW. In several of these countries, governments struggled – and arguably failed – to respond quickly enough with tariff reductions, to sharp falls in the cost of PV technology. These made the economics of building capacity very attractive for developers. By late in the year, countries such as Germany and the UK were moving aggressively to impose cuts in tariffs and limits on the types of PV project that would be eligible for the most generous support in the future.

Overall, Europe saw investment of $101 billion in renewable energy in 2011, up 10% on the previous year. The biggest asset financings were in offshore wind, with a quartet of financings in Germany and Denmark, all for between $1.3 billion and $2.8 billion, the largest being for the 400MW Global Tech 1 projects off the German coast. Solar thermal projects also featured prominently, with five financings in Spain, each worth between $520 million and $1.2 billion, the biggest being for the 100MW Nextera Termosol plant. Further details of projects financed in 2011 are provided in Chapter 4 on asset finance.

FIGURE 21: VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN ITALY BY SECTOR, 2011, $BN

Units: $bn	Asset finance*	Public markets	VC/PE	Total
Solar	3.7	0.1	-	3.7
Wind	0.6	-	-	0.6
Biomass & w-t-e	-	0.2	-	0.2
Biofuels	0.2	-	-	0.2

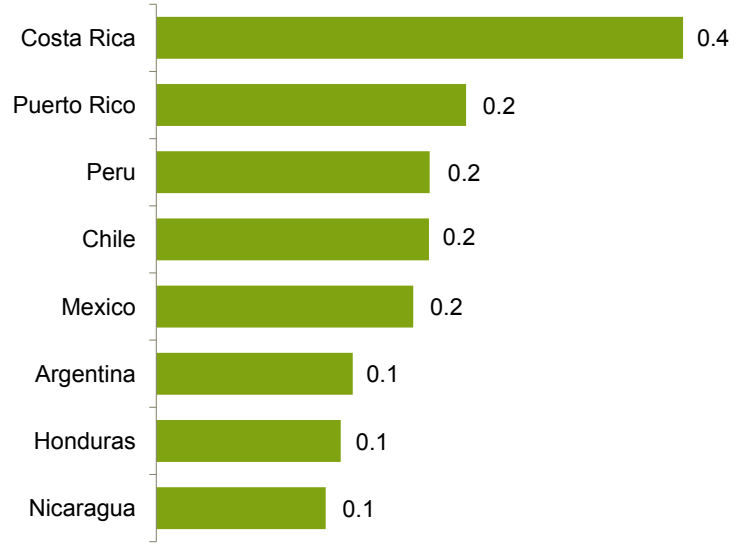
*Asset finance volume adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

OTHER ECONOMIES

It is easy to think of the renewable energy sector worldwide as overwhelmingly a creature of Europe, the US and China, India and Brazil. However, some 13% of total investment in 2011 took place outside these economic powerhouses, and this proportion has been above 10% in each of the last eight years. Total investment in the Americas, excluding the US and Brazil, was $7 billion in 2011, while that in the Middle East and Africa was $5.5 billion and that in Asia-Oceania outside China and India was $21.1 billion. The last of the three was the only one to show growth last year, at 15%. A mixture of factors held investment back in the Middle East and Africa and in non-Brazil Latin America.

FIGURE 22: TOTAL VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN LATIN AMERICA (EXCLUDING BRAZIL), 2011, $BN



Omits countries with less than $0.1bn investment. Investment volume adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

Among the other countries outside Europe and the US that were significant investors in renewable energy in 2011 were Canada, with investment of $5 billion excluding small-scale projects and R&D, down 8%; Australia, with investment of $1 billion excluding the same items, down 59%; and New Zealand, up fivefold at $760 million.

OTHER LATIN AMERICA

Last year was a year of transition for some important Latin American renewable energy markets. Mexico is a country currently seeing strong interest from European utilities and investors, keen to take advantage of its natural resources in wind and solar. The government there is planning to introduce a reverse auction for 200 renewable energy projects with 20MW of capacity each, to be awarded at the beginning of 2013. Mexico is also nearing grid parity for rooftop solar, a development that should allow rapid expansion of the PV market from 2012 onwards.

There has been a rush of recent activity in Mexico, including Macquarie Mexican Infrastructure Fund managing in February 2012 to secure $692.5 million worth of debt for a 396MW wind project in the south of the country, and Siliken of Spain announcing plans to build a $300 million PV plant in the northern state of Durango, creating what would be country's largest such project at 100MW. However few actual financing closes of any size took place in Mexico inside calendar year 2011.

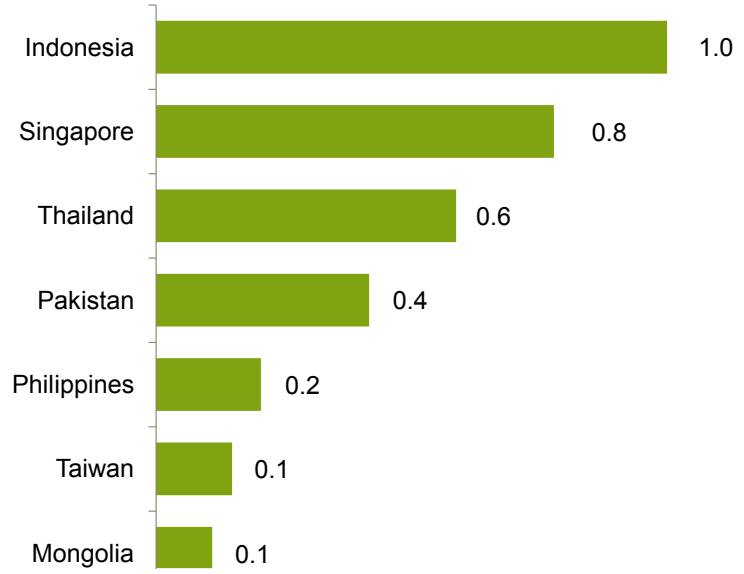
Figure 22 shows that investment activity was subdued in other parts of Latin America, outside Brazil, in 2011. It excludes small-scale projects and R&D, but in the remaining areas of utility-scale asset finance, public markets investment and venture capital and private equity outlays, none of the countries achieved total investment of $1 billion in the year.

Argentina was one important country conspicuous by the modesty of its investment level in 2011. There were a number of small deals in wind and biodiesel, including the bond financing of an 80MW wind portfolio in the third quarter. But more ambitious plans, such as WPD of Germany's move to develop 150MW of wind capacity in western Argentina with a local utility, did not produce financings in the 2011 calendar year. Argentina, like Colombia, increased biodiesel output with the help of a blending mandate, but this production took place largely at existing plants.

OTHER ASIA

A similar story applied to Asia, outside China and India. Figure 23 shows that Indonesia attracted the largest total for asset finance, public markets and venture capital and private equity, at $1 billion, up fivefold on 2010. Among the transactions there was the financing of 150MW of Pertamina Ulubelu & Lahendong geothermal projects, at $575 million, and a smattering of smaller geothermal and wind investments.

FIGURE 23: TOTAL VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN NON-OECD ASIA (EXCLUDING CHINA AND INDIA), 2011, $BN



Omits countries with less than $0.1bn investment. Investment volume adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

Indonesia was followed by Singapore with $767 million of investment, up seven-fold, and Thailand at $578 million, down 38%. There were some surprisingly low figures, below the $100 million level, in Malaysia – for several years a significant player in biofuels – and Pakistan, which has seen increased interest in its wind sector but had many fewer deals reaching financial close in 2011 than in 2010.

There is much more ambition for renewable energy in southeast Asia than demonstrated by the investment totals of 2011. The five countries of Indonesia, Vietnam, Thailand, Malaysia and the Philippines have targets to install a total of 32GW of renewable power in the period 2011-25, with Indonesia the most aggressive at 12GW, and Thailand and Malaysia offering the most generous subsidies. Geothermal and biomass and waste-to-power are the sectors in the strongest position to benefit from this investment drive in the region.

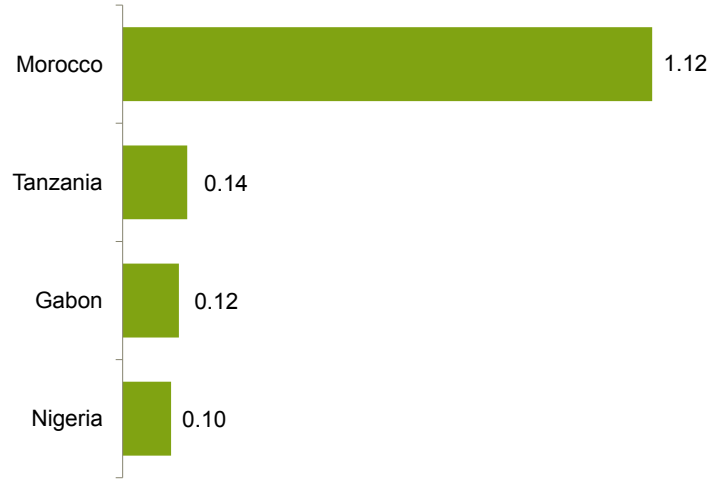
MIDDLE EAST AND AFRICA

These regions disappointed in 2011. South Africa has been the scene of significant policy-making and investor activity, but as with Mexico, few transactions actually closed during last year. The Middle East meanwhile, which had been the centre of hopes for wind and solar capacity installation in 2011, was swept by the Arab Spring and this led directly to the postponement of some renewable energy tenders and indirectly to some hesitation by international investors worried about political risk.

Nevertheless Morocco led the Middle East and African regions in terms of renewable energy investment (excluding R&D and small-scale projects), with $1.1 billion, up from very low levels in 2010. It was followed by the United Arab Emirates on $837 million, up 40-fold, and by Turkey on $422 million, down 63%.

With the exception of Morocco, investment in African countries was disappointing in 2011. Figure 24 shows investment in some of them. One notable absentee from the list is South Africa, where actual investment was very modest in 2011, in the low millions. However this should be the lull before a gale. There was a strong focus by the Department of Energy in Pretoria on re-structuring policy, targets and incentives. In 2011,

FIGURE 24: TOTAL VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN AFRICA, 2011, $BN



Omits countries with less than $0.1bn investment. Investment volume adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

the country held the first round of its renewable energy tender for up to 3.7GW of capacity, and in December announced 28 winning bids totalling 1.4GW. If financing and power purchase deals can be finalised, that could lead to 634MW of wind capacity additions, 632MW of PV and 150MW of solar thermal.

South Africa released an Integrated Resource Plan in May 2011, calling for the development of 40GW of new generation capacity up to 2030 including 17.8GW of renewable energy (42%), 9.6GW of nuclear energy (23%) and 6.3GW of new coal (15%) along with the 10.1GW of already committed new coal.

Kenya has arguably been the most prominent sub-Saharan country to date in terms of renewable energy outlays, and it achieved investment of $2.5 billion in 2010. However this shrunk sharply in 2011, to well below $100 million, not due to any lessening in ambition but more due to the fact that large projects did not reach the stage of financial close during the calendar year. In wind, large projects such as the 310MW Lake Turkana undertaking and the 160MW Aeolus Kinangop concern tip-toed forward but remained tantalisingly short of financial close.

Geothermal also saw activity in Kenya in 2011, with Ormat announcing in September that it was aiming to reach financial close on a $310 million loan from the Overseas Private Investment Corporation to fund the extension of its 48MW Olkaria III project. Also in September, Kenya's state-owned Geothermal Development Company said it received bids from 19 companies to develop eight, 100MW steam-powered electricity plants at the Bogoria-Silali block in the country's northwest.

Ambitious plans for multi-MW renewable power installations were announced in several African countries, including Lesotho (wind), Guinea (solar) and Rwanda (geothermal) during the year. In Rwanda's case, its energy minister said in May 2011 that it planned to start sinking wells in an area that could offer up to 700MW of geothermal power.

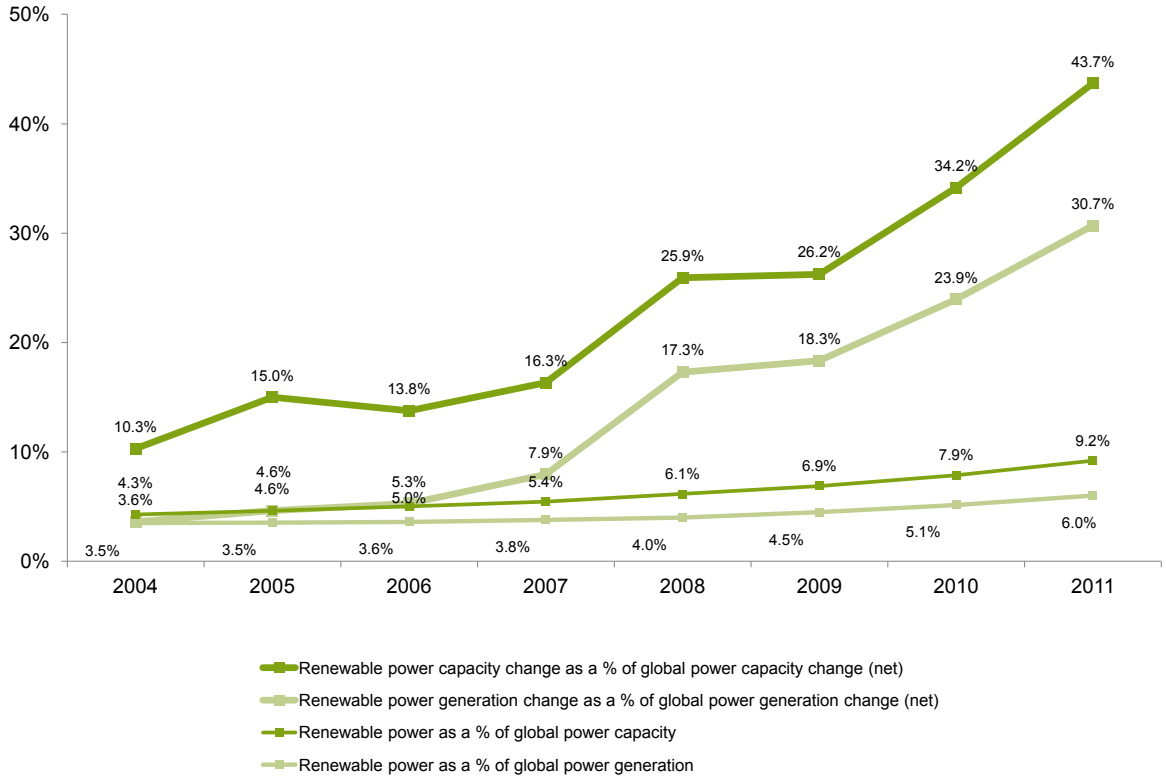
PUTTING RENEWABLE ENERGY INVESTMENT IN PERSPECTIVE

- Renewable power, excluding large hydro-electric, accounted for 44% of new generation capacity added worldwide in 2011, up from 34% in 2010, and 31% of actual new power generated due to the intermittency of the wind and solar capacity added.
- The proportion of power generated by renewables excluding large hydro rose to 6% in 2011 from 5.1% the previous year, the low figure reflecting the huge amount of non-renewable capacity already existing.
- Gross investment in fossil-fuel generating capacity in 2011 was $302 billion, compared to $237 billion for that in renewables excluding large hydro.
- However, if spending on replacement plant is excluded, and investment in large hydro included, then net investment in renewable power capacity was about $262.5 billion, some $40 billion higher than the same measure for fossil-fuel.
- The competitiveness of renewable power is improving rapidly, with the levelised cost of generation from PV down 31-35% in the 12 months to the first quarter of 2012 alone, and the equivalent figure for onshore wind down 9%. Only offshore wind of the main technologies saw costs increase last year.
- On the climate front the scaling up of investment in renewables provides some confidence that global emissions can indeed be brought onto a sustainable trajectory. However a significant gap in ambition remains on the part of governments if the global economy is to be decarbonised in time.
- Investment in energy-smart technologies, via public markets, venture capital and private equity and government and corporate R&D, was $18.9 billion in 2011, down 18% on 2010. These technologies include smart grid, efficiency, power storage and advanced transportation.

This chapter provides context on the wider energy sector, of which renewables form a growing part. It asks how significant renewables really are compared to the whole sector, both in terms of the investment they are attracting, and the power they are generating. It also examines whether the relatively young technologies of renewable power are making progress towards competitiveness with established fossil-fuel generation – in short, whether "the kids are growing up".

The third section of the chapter discusses how the investment in renewable energy is only one strand of global attempts to curb emissions and prevent dangerous climate change, and looks at projections of how emissions might change in coming decades. It then compares renewable energy investment figures and recent trends in energy-smart technologies with the financing that will be required to achieve universal energy access in the developing world.

FIGURE 25: RENEWABLE POWER GENERATION AND CAPACITY AS A PROPORTION OF GLOBAL POWER, 2004-2011 %



Sources: EIA, IEA, Bloomberg New Energy Finance

RENEWABLES VERSUS FOSSIL FUELS

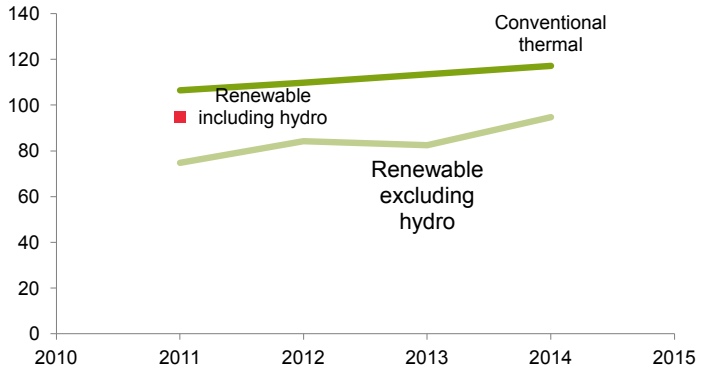
The comparison below provides both cheering, and worrying, messages for those hoping to see a rapid shift to low-carbon energy worldwide. Figure 25 shows that renewable power (excluding large hydro) has continued to account for an increasing share of the overall generation capacity added worldwide. In 2011, this rose to 44% from 34% in 2010 and 26% in 2009. Back in 2004, the proportion was just 10%. Last year, renewables excluding large hydro made up 9.2% of total world generating capacity, up from 7.9% in 2010, 6.9% in 2009, and 4.3% in 2004[5].

In terms of actual electricity generated, renewables excluding large hydro made up 31% of the extra generation in 2011, although overall they still only accounted for 6% of total electricity produced in that year. The latter figure has been inching up – from 5.1% in 2010, 4.5% in 2009 and 3.5% back in 2004 – but progress is relatively slow because there is also a significant amount of additional fossil-fuel capacity coming online each year, and because most of the renewable energy capacity added (wind and PV in particular) is intermittent, often with capacity factors of 15% to 30% rather than the higher figures possible with fossil-fuel generation, nuclear and large hydro.

Figure 26 shows the comparison between net capacity added in fossil-fuel power and that added in renewable power in 2011 and beyond. As mentioned above, renewable power excluding large hydro made up 44% of total net additions in 2011. Capacity added in renewables excluding large hydro was 82GW in 2011, still well short of the net 106GW of conventional thermal capacity added worldwide. However the comparison tightens if large hydro is added to the renewable figure – 15GW of large hydro takes all renewables added in 2011 to 97GW, some 9GW short of the thermal figure.

[5] These percentages are not identical to those published by the International Energy Agency in its 2011 World Energy Outlook. One difference is that the IEA numbers for 2009 exclude all hydro, not just large hydro.

FIGURE 26: FORECAST ANNUAL NET CAPACITY ADDITIONS OF FOSSIL-FUEL AND RENEWABLE POWER, 2011-2014, GW



Renewable power forecast based on Bloomberg New Energy Finance projections for wind, solar, bioenergy and geothermal. Conventional thermal capacity projection based on IEA compound growth rate.
Sources: EIA, IEA, Bloomberg New Energy Finance

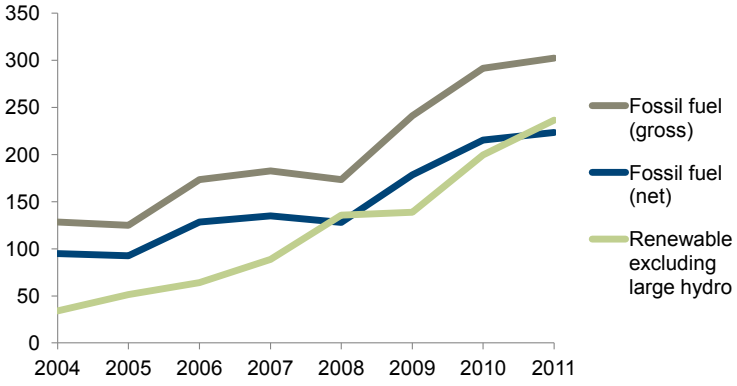
The trend for the next few years is for conventional thermal capacity to continue to grow, so that even though renewables excluding hydro will also see more and more GW added, there will continue to be a gap between the two. Bloomberg New Energy Finance's Global Renewable Energy Market Outlook, published in November 2011, predicted that the total renewables addition would not overtake the net thermal addition until the middle of this decade[6].

Figure 27 shows that gross investment in fossil-fuel capacity continued to run ahead of renewable power excluding large hydro in 2011 – at $302 billion against $237 billion. The nearest this gap has come to closing came in 2008, when a surge in wind investment, in particular, coincided with a plunge in fossil-fuel capacity investment during the credit crunch.

However there are two other ways of looking at the investment comparison. The first is to look at net investment – because a significant part of the gross investment in fossil-fuel capacity is actually to replace clapped-out coal and oil-fired capacity with newer plant. If we look at the amount of money invested in additional fossil-fuel capacity and compare it to the amount invested in renewables capacity (excluding large hydro), then the figures concerned are $223 billion and $237 billion – a gap in favour of renewables of $14 billion. This is in contrast both to the comparison on gross investment above, and to the one between net GW capacity added in fossil-fuel power and net GW added in renewables. In the latter cases, this reflects the fact that the upfront capital cost of renewable power is greater than that of conventional thermal – while the operating costs with wind and solar, for example, are generally much lower.

If large hydro is included in the definition of renewable power, then the comparison on investment dollars in 2011 shifts once again. The box on large hydro in Chapter 4 of this report presents an estimate that some 15GW of large hydro capacity was commissioned during 2011, less than in some recent years. The timing of the investment decision on a large hydropower project may be about four years on average away from the moment of commissioning, so the coming estimate is very much an approximate one only. If the capital cost per MW of large hydro is around $1.7 million, then that figure times 15GW would give a figure for investment of $25.5 billion, taking

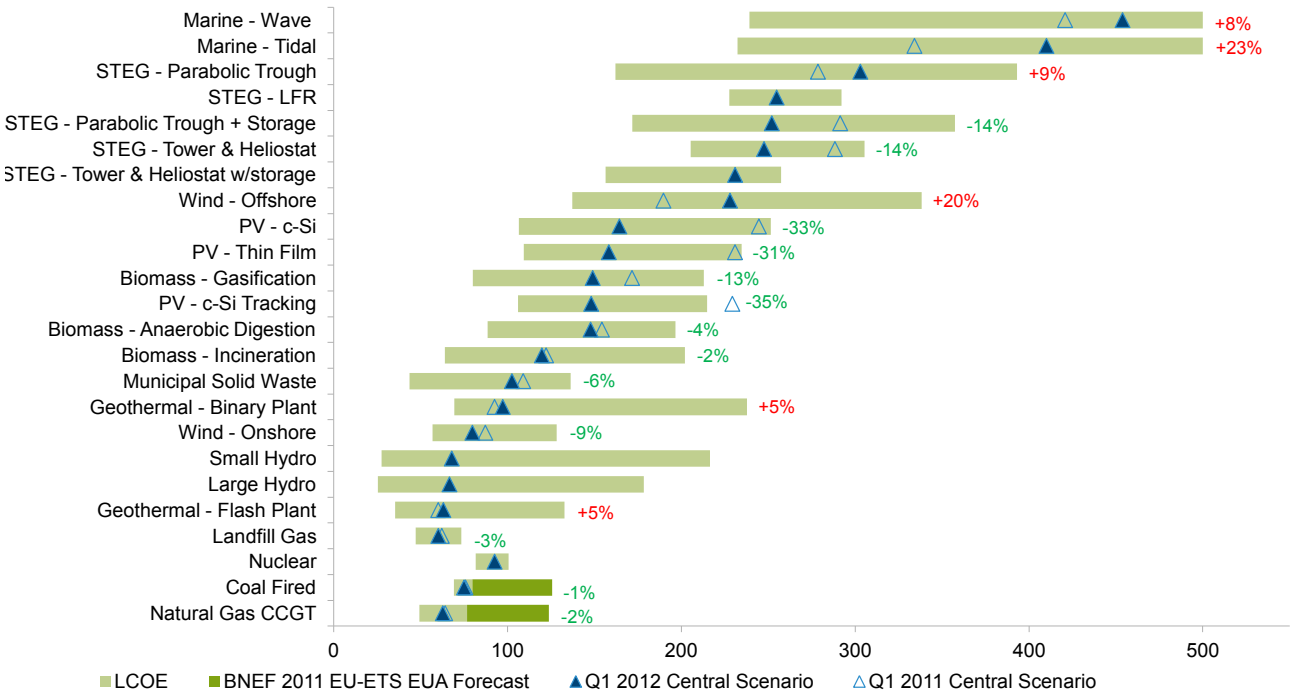
FIGURE 27: INVESTMENT IN CLEAN ENERGY V CONVENTIONAL CAPACITY, 2004-2011, $BN



Fossil fuel investment is calculated from EIA and IEA data. Renewable energy investment includes asset finance and small-scale projects, but excludes large hydro.
Sources: EIA, IEA, Bloomberg New Energy Finance

6. Bloomberg New Energy Finance, Global Renewable Energy Market Outlook, published November 2011.

FIGURE 28: LEVELISED COST OF ELECTRICITY FOR DIFFERENT GENERATION TECHNOLOGIES, Q1 2012 V Q1 2011 $ PER MWH



Source: Bloomberg New Energy Finance estimates

investment in all additional renewable power capacity in 2011 to $262.5 billion, well above net investment in fossil-fuel capacity of $223 billion but well below gross investment in fossil-fuel capacity of $302 billion.

The fact that renewables were ahead of fossil-fuel power in 2011 on the basis of some, but not all, ways of comparing investment may be reassuring. But it does not alter the fact that the world is continuing to add more conventional thermal than renewable power capacity, jeopardising attempts to curb emissions and limit changes to the climate. We look at the emissions outlook in the third section of this chapter. Before that we examine trends in cost between different power sources.

TRENDS IN COMPETITIVENESS

One of the most exciting developments in the renewable energy sector in recent years has been the decline in the cost of important technologies – to the point at which they are starting to challenge fossil-fuel alternatives, even without climate, health and other benefits factored in.

The most spectacular change was the plunge in prices along the PV supply chain, caused by increased competition, particularly from China, leading to severe, global excess capacity. The selling prices of PV cells fell from $1.50 per Watt in September 2010, to $1.30 per Watt by January 2011 and only just over $0.60 per Watt by the end of the year[7]. Overall, PV module prices at the start of 2012 were nearly 50% down on a year earlier, and some 76% below their level in the summer of 2008, when the Spanish PV boom was at its height.

Something similar was going on in onshore wind, albeit not quite as extreme. In 2011, turbine prices for delivery in the second half of 2013 were averaging around EUR 0.91 per MW ($1.265 per MW at the average euro-dollar exchange rate last year), compared to a peak of EUR 1.21 per MW for devices delivered in the first half of 2009 – a reduction in price of 25%. Improving technology

7. Bloomberg New Energy Finance's Solar Spot Price Index

was one reason but the dominant one, as in PV, was industry over-capacity as demand failed to keep up with increases in supply.

Figure 28 shows the change in the levelised cost of electricity (LCOE) of 24 different technologies between the first quarter of 2011 and the first quarter of 2012, using Bloomberg New Energy Finance's LCOE model. This model has as its inputs estimates of capital cost per MW, average feedstock costs, cost of debt, length of loan, operating and maintenance expense, depreciation and other variables. Nuclear is included in the estimates on Figure 28, but its figure is indicative only, because of the difficulty of estimating accurately cost elements such as disaster insurance (often provided implicitly by governments, as the Fukushima crisis showed), and long-term nuclear waste storage.

In the year in question (Q1 2011 to Q1 2012), there were significant falls in the costs of generating a MWh of power from onshore wind (down 9%), and from PV technologies (the crystalline silicon variety with tracking down 35% and the thin-film variety down 31%). The cost of energy from fossil-fuel sources was little changed over the same period, with coal-fired generation costs down 1% and combined-cycle gas turbine, or CCGT, costs down 2%, helped by low US gas prices. The dark shading on the chart alongside coal-fired and CCGT shows an estimate of what the costs of generation using these fossil-fuel technologies would be if the price of carbon was included.

The less common renewable energy technologies also showed mixed fortunes in 2011. At the low end of the cost range (towards the left of Figure 28), geothermal flash plants saw their cost of generation increase by 5%, but there was a 2% fall for biomass incineration and a 13% drop for biomass gasification. Among the solar thermal technologies, parabolic trough costs increased 9% on the back of higher prices for materials, but the version with storage improved its economy by 14% as developers improved their knowhow on maximising power output and generating hours. Wave and tidal stream technologies remained the most expensive, but there are several dozen different devices being developed in these areas, most of them at a fairly early or prototype stage. The costs of generation in marine will come down as the successful machines are made at optimum capacity and enter mass production – but they are still likely to be above those of onshore wind, coal or gas-fired power.

Over two years to the first quarter of 2012, this LCOE model shows that PV-generated electricity has fallen in cost by some 44%, and onshore wind power by some 7%. Meanwhile CCGT power has seen a 6% increase, and coal-fired power a 9% rise over that same period.

The most significant exception to the trend of lower renewable power generation costs in Figure 28 is offshore wind, which saw a 20% rise in the year to the first quarter. This reflected a combination of a shift by the industry towards deeper-water projects, and a shortage of competition in the supply of items such as high-voltage export cables and installation ships. The levelised cost of electricity for offshore wind is expected to fall from the middle of this decade

onwards, as competition increases in the supply chain, more efficient turbines are introduced and expertise improves on installation.

Based on current cost reduction trends, it is predicted that the average onshore wind project worldwide will be fully competitive with combined-cycle gas turbine generation by 2016[8]. At present, this is true only of a minority of wind projects, those that use the most efficient turbines in locations with superior wind resources. In PV, analysis suggests that the cost of producing power from rooftop panels for domestic use is already competitive with the retail (but not the wholesale) electricity price in several countries – see Chapter 5 and Figure 39. Large-scale PV plants are still a significant distance away from competitiveness with wholesale power prices.

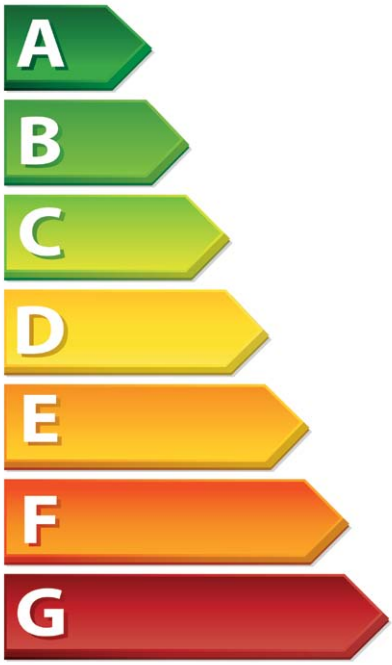
RENEWABLES AND CLIMATE CHANGE MITIGATION

Renewable energy is only part of the international effort to limit climate change. Other strands to the approach include energy efficiency (see box below), other low-carbon energy options such as nuclear, large hydro-electric and even replacing coal-fired with gas-fired generation, plus carbon capture and storage, and reducing emissions from deforestation.

The International Energy Agency's World Energy Outlook 2011, published last November, warned that if "bold policy options are not put in place over the next several years, it will become increasingly difficult and costly to meet the goal…..of limiting a global temperature increase to two degrees Centigrade". Even if new policies are adopted to stimulate investment, such as subsidies for clean energy, tighter emission regulations or taxes on pollution, the IEA predicts that the world is on track for a rise in temperatures of 3.5 degrees, and if the new policies are not brought in, the rise could be six degrees Centigrade. The agency called for measures to increase efficiency, including tighter standards across all sectors and a partial phase-out of fossil fuel subsidies, which it estimated rose to a record $409 billion in 2010.

The IEA's most ambitious projection, its "450" Scenario, would see the carbon dioxide content of the atmosphere restricted to 450 parts per million and the global temperature increase to two degrees Centigrade. This however would involve CO2 emissions peaking before 2020 and then falling, by 2035, to 1990 levels. It estimated that 44% of this abatement by 2035 would come from efficiency measures, 21% from the use of renewable power, 4% from the adoption of biofuels, 9% from the use of nuclear, and 22% from the use of carbon capture and storage.

Current predictions are that total installed capacity in non-hydro renewable power will rise ninefold to 2.5TW by 2030, with investment in assets rising from $225 billion in 2011 to $395 billion-a-year by 2020 and $460 billion-a-year by 2030[9]. However this forecast is cautious on emissions. It sees those in the European Union Emissions Trading System area, for instance, rising nearly 2% overall between 2011 and 2030. Within this, the model has power sector emissions falling 16% and heat and local power by 14%, but cement and lime sector emissions jumping 68%, aviation by 45%, steel by 26% and refining by 4%[10].



[8] Bloomberg New Energy Finance. See http://bnef.com/PressReleases/view/172
[9] Bloomberg New Energy Finance, Global Renewable Energy Market Outlook, published November 2011.
[10] Ibid

UNEP has examined whether the pledges made by governments within the Copenhagen Accord of 2009 are sufficient to limit global warming to two degrees Centigrade, or 1.5 degrees Centigrade. This effort has calculated that if the highest ambitions from Copenhagen are implemented, annual emissions could be cut by around seven gigatons (Gt), to 49Gt of carbon dioxide equivalent by 2020. This would still however leave a gap of around 5Gt compared with where we need to be — a gap equal to the total emissions of the world's cars, buses and trucks in 2005. The Durban climate change conference in December 2011, did, however, bring major parties' negotiating positions closer together, with developed countries moving forward on their commitment to set up a Green Climate Fund that will assist developing countries to mobilise the needed investment, and China and India both taking a more open stance towards the idea of taking on an emissions target at a later date.

SUSTAINABLE ENERGY FOR ALL

During 2011, UN Secretary-General Ban Ki-moon launched a global initiative on Sustainable Energy for All aimed at mobilising action in support of three interlinked objectives to be achieved by 2030: doubling the share of renewable energy in the global energy mix; doubling the global rate of improvement in energy efficiency; and providing universal access to modern energy services.

On the renewables objective, the baseline share for renewables within the energy mix is 16% today. Therefore a doubling would require increasing this to 32%. As was discussed earlier, excluding large hydro, renewable technologies already account for about 31% of newly installed power generation. However getting the overall energy mix to 32% renewable by 2030 will be a Herculean challenge due to the long operating lives of existing power plants. Doubling the global rate of improvement in energy efficiency is much more doable in the short term as it requires changing patterns of investment in new-build infrastructure on a magnitude that is similar to what has already been done for renewables. The box below on energy-smart technologies gives some indication of how progress is being made on this objective.

The third Sustainable Energy for All objective of achieving universal access to modern energy services seems most nearly within society's reach, requiring a capital mobilisation that is somewhat modest compared to the recent trends in renewables investment. The IEA has estimated that achieving universal energy access by 2030 will require investment of $48 billion dollars annually, up from $9 billion today. Although this would require a significant scaling up of both public and private sector engagement in the energy sectors of the least developed countries, the total capital outlay is only 19% of the investment mobilised globally for the renewables sector in 2011, or 41% of that in the developing world. Considering the social, environmental and economic benefits of bringing modern energy services to the 1.3 billion people today that lack electricity to light their homes and businesses, and the 2.7 billion that do not have clean cooking facilities, the required overall investment seems somewhat modest and achievable based on the recent capital mobilisation experience of the renewables sector globally.

BRINGING PERSPECTIVE TO RIO

The overall message from this year's Global Trends report is that 2011 was once again a year of record investment in renewables but that the risks of an interruption to investment growth have increased. As the following chapter will examine, the sector today is in the most difficult phase of a transition to a green economy, one in which the pain and cost for some individual companies and countries becomes clearer. As governments meet for the Rio+20 UN Conference on Sustainable Development, their ability to shift towards a green global economy will be a central and important theme for discussion and will depend on policy-makers and investors holding their nerve in the difficult transitions that this greening will entail.

ENERGY-SMART TECHNOLOGIES

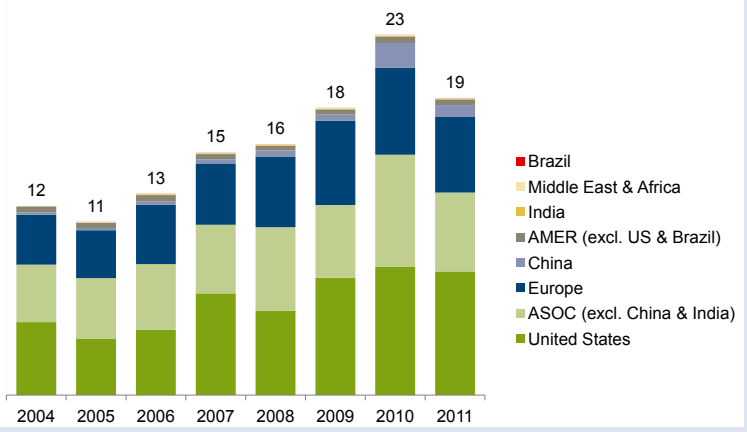
This description embraces a group of technologies, all of which make possible the more efficient use of electricity and fuels. They include digital energy products such as smart meters, home energy management systems and software for the better management of intermittent generation in the grid.

A second category is energy storage, covering batteries and fuel cells and other technologies such as flywheels, fast reserves and short-term operating reserves. A third is energy efficiency, including light-emitting diodes, or LEDs, demand response, heat pumps and insulation. A fourth is advanced transportation, including electric and hybrid vehicles.

None of these technologies count as renewable energy, but they do hold the promise to make another, important contribution to limiting world emissions. The European Union's 2050 Energy Roadmap, for instance, published in December 2011, outlined scenarios in which the use of efficiency could cut power use by anywhere between 11.6% and 40.6% by 2050 compared to 1990 levels, contributing to an 85% cut in overall emissions.

Investment in energy-smart technologies worldwide was $18.9 billion in 2011, the second-highest year ever but 18% lower than in 2010 (see Figure 29). This total encompasses venture capital, private equity and public markets fundraising for specialist energy-smart technology companies, plus government and corporate R&D in this area. It does not include project investment – such as installing insulation in buildings, or replacing fluorescent light-bulbs with LEDs – since this would be almost impossible to measure.

FIGURE 29: GLOBAL NEW INVESTMENT IN ENERGY-SMART TECHNOLOGIES BY REGION, 2004-2011, $BN



Includes fundraisings of energy smart technology companies through VC/PE or PM transactions as well as R&D estimates.
Source: Bloomberg New Energy Finance

Within that $18.9 billion figure, corporate R&D was $7.8 billion, down 13% from 2010, hit by the uncertain state of the world economy and the financial markets last year. Government R&D was $6.4 billion, down from $8.7 billion, reflecting a smaller commitment to energy-smart technologies from the "green stimulus" packages launched in 2008-09. Public markets investment was $1.5 billion, down from $2.2 billion, but venture capital and private equity commitments were up 4% at a record $3.2 billion. Within the wide clean energy area, energy-smart technologies have vied with solar for several years as the most popular destination for venture capital funds.

THE GREEN ECONOMY - GAINS AND STRAINS

- The rising tide of investment in renewable energy has been the most visible aspect so far of the hoped-for transition to a "green economy".
- It has also made a small contribution to the recovery in the global economy since the financial crisis of 2008, and by 2011 the two largest sectors – wind and solar power – accounted for an estimated 1.2 million full-time jobs worldwide.
- Specialist renewable energy technologies are providing fresh choices on energy access in developing countries, and offering alternatives to uneconomic fossil-fuel sources such as off-grid diesel generators, and oil-fired generation in hydrocarbon-rich countries.
- However, the transition to low-carbon power and fuels is also causing strains. These range from company failures in the face of industry over-capacity, to pressure on electricity bills.

THE OBJECTIVE OF A GREEN ECONOMY

The UN Conference on Sustainable Development, called Rio+20, has as one of its two themes "a green economy in the context of sustainable development and poverty eradication". Seven areas are being focused on – jobs, energy, cities, food, water, oceans and disasters. As well as the core area of environmental sustainability (climate, water supplies, resources), there is a clear emphasis also on social inclusion and "intragenerational and intergenerational equity"[11].

This chapter concentrates on the impact of efforts to achieve one part of that broad objective - the key environmental aim of sustainability in the energy system. This process has gone on, past the early phase of excitement about new renewable energy technology, and into a more difficult phase in which not only the benefits, but also the costs, have become clearer.

GREEN ECONOMY GAINS

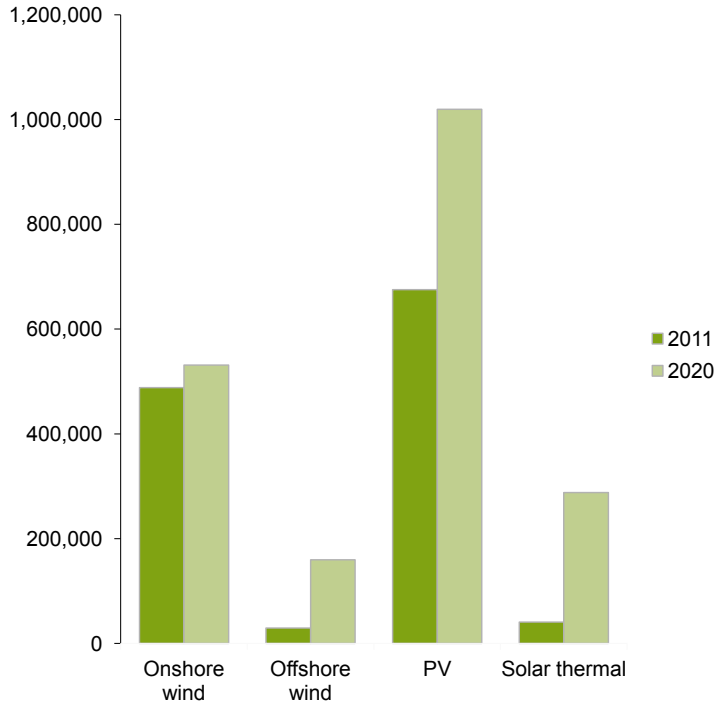
Three potential benefits to be had from the low-carbon transition are greater efficiency in the use of energy, reduced reliance on fossil fuels and job creation.

The addition of renewable power sources such as wind and solar to the grid is forcing utilities around the world to invest in more advanced grid management systems to cope with intermittency and rapid switching between generating assets. This is most effective when paired with technologies such as demand response and home energy management, to influence via pricing signals when consumers and businesses choose to use power. That in turn leads to greater efficiency in energy consumption.

In the developing world, although the largest share of renewables investment is still going to the larger economies (see Strains section below), the economic rationale for spurring renewables uptake in the least developed countries is gaining ground. According to the International Energy Agency, developing countries that import oil today are facing prices in excess of $100 a barrel when, at a comparable stage of economic development, many OECD countries faced an average oil price of around $22 a barrel (in 2010 dollars)[12]. In little over a decade, the IEA estimates that the bill of oil importing less developed countries has quadrupled to hit an estimated $100 billion in 2011, or 5.5% of their gross domestic product.

[11] See Objective And Themes Of The United Nations Conference On Sustainable Development, report of the Secretary-General, December 2010.
[12] Energy for All, Financing access for the poor – Special early excerpt of the World Energy Outlook 2011, International Energy Agency, 2011.

FIGURE 30: FULL-TIME EQUIVALENT EMPLOYMENT IN WIND AND SOLAR IN 2011 AND 2020



Source: Bloomberg New Energy Finance estimates, March 2012

In many countries the true costs of fossil fuel use are becoming increasingly clear. For instance in the US a 2011 study from the New York Academy of Sciences estimated that the life-cycle effects of coal and the waste stream generated double to triple the cost of coal generation in the US, costing the public a third to over one-half of a trillion dollars annually[13].

Renewables are starting to offer up a wide range of opportunities for shifting away from fossil fuels. Besides displacing fossil fuelled generation on the grid, the Focus Chapter in the 2011 Global Trends report presented a variety of new technology and business models - including solar cooking, rice-husk gasification, telecom towers and municipal waste-to-power - that are now seeing uptake in emerging economies[14].

Rising investment in renewable energy has also made a useful contribution to economic recovery in recent years. The $90 billion in additional renewable energy investment between 2008 and 2011 compares to $7.4 trillion in additional world output at market exchange rates between those years, according to the International Monetary Fund[15]. This would be equivalent to 1.2% of that output gain, although the two numbers are made up of different components, and are not strictly comparable.

A more tangible bonus from green economy is job creation. Analysis earlier this year by Bloomberg New Energy Finance built up estimates for employment in 30 parts of the wind and solar value chains, from operating and maintaining wind farms, to installing PV panels on roofs, from manufacturing offshore wind turbines, to making the reflectors and other specialised equipment for solar thermal, or CSP, plants[16].

It found that in 2011, the onshore wind sector and its sub-contractors employed 488,000 people, while the PV sector employed 675,000. The biggest job-creators within those sectors were wind turbine manufacture at 364,000, PV module making at 302,000, and small-scale PV installation at 231,000. There were smaller numbers employed in offshore wind, at 29,000, and solar thermal, at 41,000.

This study predicted that overall employment in wind and solar would grow from 1.2 million in 2011 to two million in 2020 (see Figure 30), as demand for these technologies increased. The jobs gain would come despite very rapid improvements in productivity - for instance workers per MW in PV module and inverter making were assumed to fall by an average of 5% per year between 2011 and 2020. Other parts of the wind and solar value chains would see productivity gains of up to 4% per year, it postulated.

Employment in bioenergy is harder to estimate, because many jobs are in the growing of the crops. There are huge differences in agricultural productivity in different parts of the world, and produce such as sugar, corn and palm oil can be

13. Epstein, P.R. et al., 2011. Full cost accounting for the life cycle of coal. K. L. I. K. Robert Costanza, ed. Annals Of The New York Academy Of Sciences, 1219(1), p.73-98.
14. Global Trends In Renewable Energy Investment 2011, UN Environment Program and Frankfurt School, see p54-58.
15. International Monetary Fund, World Economic Outlook April 2011, p181, Table A1.
16. Solar And Wind Sectors On Course to Employ 2 Million People Worldwide By 2020, Bloomberg New Energy Finance Research Note, 5 March 2012.

switched from biofuel or biomass-to-power use, to the food chain or consumption by another industry. In biomass, the agricultural employment will differ greatly whether the feedstock at any one time is forest trimmings, local municipal waste or imported pellets. However the number of jobs at the plant construction and generating stages for biomass and waste-to-power was estimated at 185,000 in 2011, rising to 397,000 by 2020.

The 2012 REN21 Global Status Report, published in parallel with the Global Trends 2012 report, includes estimates of 750,000 people employed in the entire biomass value chain worldwide, and 1.5 million in biofuels. This report[17] includes somewhat higher estimates for jobs in wind and solar, reflecting a different calculation methodology.

Investment in wind and solar has an effect on the timing of job creation, as well as on the amount of jobs created. In fossil-fuel generation, a significant part of the job creation is spread through the life of the power station, as coal, gas or oil feedstocks are extracted and transported to the site. By contrast, with wind and solar generation, the overwhelming majority of cost is incurred upfront, since the feedstock (wind and sunshine) is free. So wind and solar create a much higher proportion of their jobs upfront.

GREEN ECONOMY STRAINS

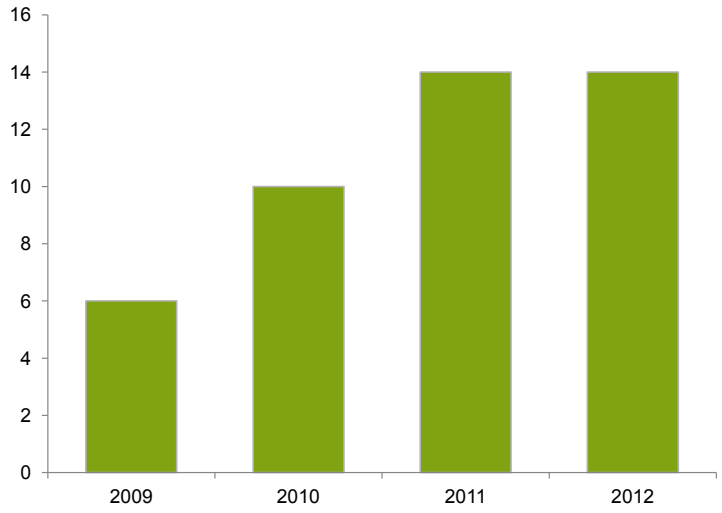
The first major strains in the shift to low-carbon energy in this century started to become evident from 2007, the year that total investment in renewable energy broke through the $100 billion-a-year barrier. That year also saw the collapse of the investment boom in US corn ethanol, and there was a gradual increase in criticisms of the biofuel industry generally over sustainability and its impact on food prices. The food-or-fuel argument heated up further in 2008, although research at the time suggested that less than 20% of the rise in the prices of grains and vegetable oils could be attributed to farmers switching to biofuel production[18].

More recently, strains have become apparent as a result of the savage shake-out in the renewable energy manufacturing industry resulting from over-capacity and tumbling prices. A series of technology-pioneering companies, such as Solyndra, Evergreen Solar and SpectraWatt in the US, and Solon, Solar Millennium and Q-Cells in Germany, have sought bankruptcy protection. Many thousands of high-skilled jobs have gone, even though they continue to be created in other companies, often in other parts of the world. Many investors have suffered too, with clean energy shares losing three quarters of their value between November 2007 and May 2012 (see full analysis of the pain in public markets in Chapter 6).

Another cost has been evident in electricity bills paid in some of the countries that were boldest in encouraging renewable energy deployment with subsidy programmes. In

[17] REN21 Renewables 2012 Global Status Report
[18] Bloomberg New Energy Finance white paper Food Price Increases: Is It Fair To Blame Biofuels? 27 May 2008

FIGURE 31: GERMAN EEG SUBSIDIES AS A PERCENTAGE OF RESIDENTIAL ELECTRICITY BILLS 2008-2012



Source: German Federal Ministry for Environment, Nature Protection and Nuclear Safety

Germany, arguably the major economy that has embraced renewable energy most wholeheartedly, the costs of subsidies provided under the EEG Renewable Energy Act amounted to 14% of household electricity bills in 2011, up sharply from 6% in 2009 (see Figure 31).

German consumers have remained broadly supportive of the sector, helped by its employment profile at home and by the fact that their economy has out-performed many of its peers since 2008. In addition, concern about nuclear power, after the March 2011 Fukushima incident in Japan, has dominated (and led to the German "Energy Turnaround", in which the government announced an earlier-than-expected move away from nuclear). Elsewhere, however, the balance of the argument has been slightly different - concern about the idea of piling costs on electricity consumers in difficult economic times has been one reason why governments from Madrid to London, and Toronto to Rome, have tried to cap the subsidies for PV power in the face of an explosion in development.

National budgets have made their own contribution to renewable energy growth – one that has been welcomed by the sector but has become more controversial subsequently. Some $195 billion of "green stimulus" programmes were promised by major economies in the immediate aftermath of the 2008 financial crisis, and $141.8 billion of that amount had been spent by the end of 2011. The US alone had spent $42 billion by the end of last year, including on its Section 1603 cash grants for renewable energy projects and the Section 1705 loan guarantees, while China had spent $44 billion.

In 2008-09, the idea of a "green recovery" was fashionable among G-20 countries – reducing carbon emissions and creating jobs in one fell-swoop – but in the latest phase of the economic downturn in developed countries, that concept has been aired much less by politicians. In some major countries, including the US and Spain, policies to support renewable energy have become more politically controversial than they were in the last decade.

One reason why some politicians may have cooled in their enthusiasm for clean energy is that the fruits of the transition are not being spread evenly. Renewable power may create jobs, as seen above, but those in manufacturing, in particular, may be on another continent rather than in the local economy near the generating project. This has led to trade friction, most recently in the US imposition of "anti-dumping" tariffs of 31% or more on Chinese-made PV equipment.

In addition, despite the advances made in local renewable energy technologies for developing countries mentioned above, the actual dollar investment in poorer states has so far been low. Sub-Saharan Africa, for example, has seen total investment in renewable energy grow strongly in percentage terms since 2004 but from an almost-negligible base. Only once, in 2010, has investment in that region accounted for more than 1% of the world total, and in 2011 it fell back to around a third of one percent. The 2011 setback may well be a temporary blip caused by the timing of large deals in places such as Kenya and South Africa, but it would take a step-change in investment levels to

prove that the transition is really benefiting Africa significantly. Meanwhile, the United Nations' Clean Development Mechanism has mostly focused so far on the larger emerging countries such as China and India, with sub-Saharan Africa excluding South Africa accounting for just 0.07% of the Certified Emission Reduction credits issued, and 1.6% of those in the pipeline. The latter was equivalent to EUR 189 million, at the May 2012 CER price of EUR 3.50-a-tonne.

Figure 32 shows how the growth of investment in renewable energy has brought a variety of gains and strains, and some of the key issues for the next phase of the green economy transition.

RIO+20 AND BEYOND

In the next two decades, the definition of "green jobs" will evolve to encompass not just a few generation technologies, but a wide sweep of economic activity including electric vehicles, efficient appliances and smart grid, efficient waste and water management, general pollution control, and also biodiversity- and resource-efficient agriculture, fisheries, forest management, industry and services.

The Rio+20 Conference will focus on the issues of reducing poverty, improving social equity and enhancing environmental sustainability. These goals are much more sweeping than merely stepping up the percentage of power generated renewably, or even reducing emissions. However the results seen so far in the renewable energy sector provide some confidence that overall greening of the economy will be possible, although still a significant challenge.

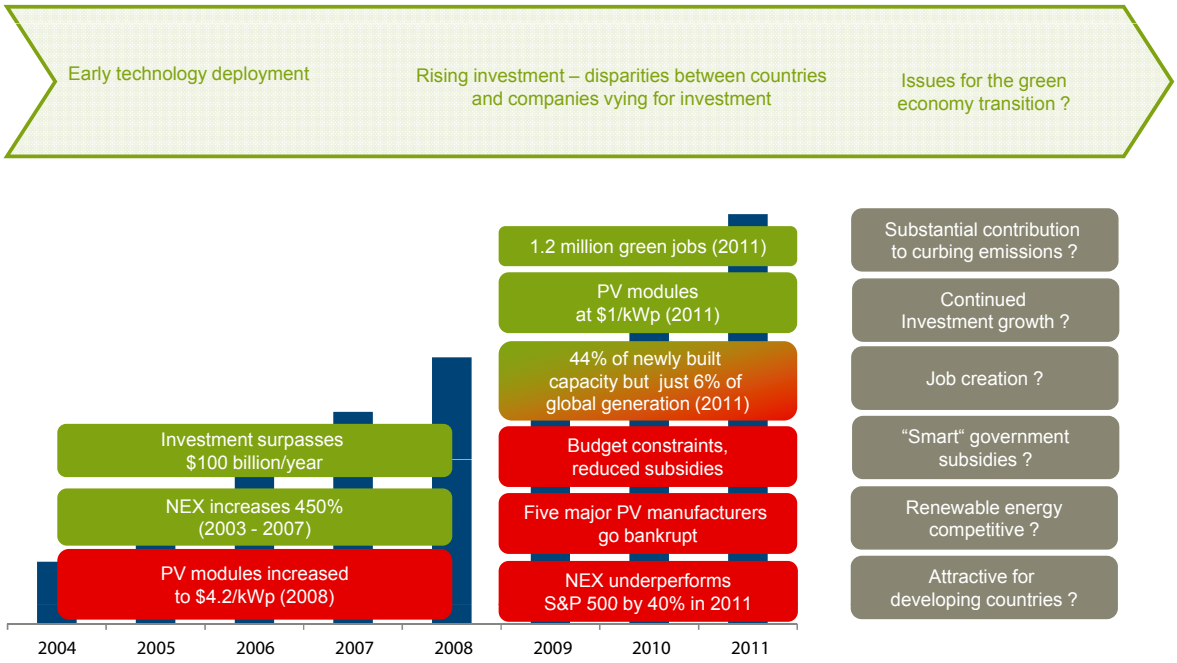
A report by UNEP's Green Economy Initiative, published in November 2011, argued that the greening of economies is "not generally a drag on growth but rather a new engine of growth"[19]. Its chapter on finance estimated that the level of additional investment needed for a global transition towards a green economy is between 1% and 2.5% of global GDP per year from 2010 to 2050. This would be equivalent to between $700 billion and $1.8 trillion per year in terms of 2012 output. The $257 billion of total investment in renewables in 2011 is certainly a step in this direction, but much more will be needed and getting to this next phase of sector growth will require broader changes across the financial community.

[19] Towards A Green Economy: Pathways To Sustainable Development And Poverty Eradication, UNEP, 2011

The UNEP Green Economy Initiative report highlights that changes in regulation and in investment culture will indeed be needed: "Fundamental aspects of international accounting systems and capital market disciplines, as well as our understanding of fiduciary responsibility in investment policy making and investment decision making, will need to evolve to fully integrate a broader range of ESG [environmental, social and corporate governance] factors than takes place today."

Making these required changes to our financial and energy systems will require great political will, economic and corporate innovation. The following chapters on the current trends in renewable energy investment provide information that might help smooth the transition to a green economy and help policy-makers and investors hold their nerve in the challenging times ahead.

FIGURE 32: RENEWABLE ENERGY'S BUMPY PATH TO THE GREEN ECONOMY



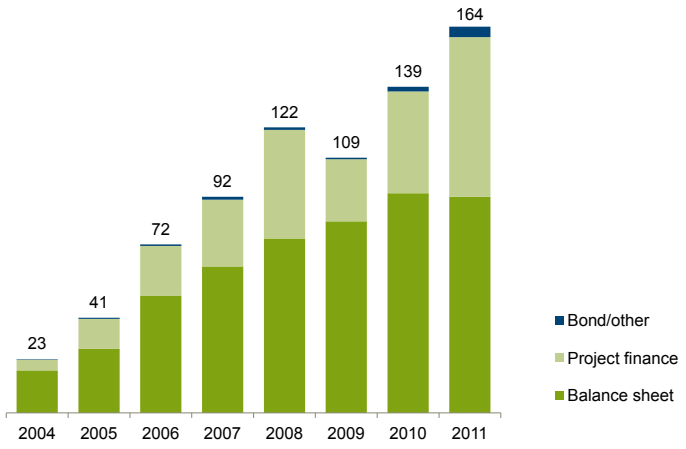
Source: UNEP, Frankfurt School

ASSET FINANCE

- Asset finance of utility-scale renewable energy projects increased 18% to $164 billion in 2011 - making up nearly 64% of total new investment in the sector.
- Solar asset finance jumped 147% to $62.1 billion, fuelled by investment decisions on a clutch of large-scale projects in the US, in both PV and solar thermal.
- Wind asset finance slipped 11% to $82.4 billion in 2011, despite several billion-dollar deals in the European offshore sector. Onshore wind stumbled in North America and Europe.
- Biofuels, biomass-to-power and geothermal all saw falls in asset finance in 2011, but there was strong growth for small hydro.
- China once again led the world in renewable energy asset finance, seeing 20% growth to $49.7 billion. Its wind sector continued to dominate, although the signs are that 2011 may well prove to be the near-term peak for China wind investment.
- Asset finance in the "bond/other" category increased its share of the total cake in 2011, to reach a figure in dollar terms six times that of 2009.

In the ongoing shift towards a green economy, asset finance of utility-scale (1MW-plus) renewable power projects, and biofuel plants, has played by far the greatest role so far. This has consistently been the largest category of renewable energy investment in recent years, and was so once again in 2011, although as a proportion of total investment it has slipped from 73% in 2008 to 64% last year, as small-scale capacity has grown in importance (see next chapter).

FIGURE 33: ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY TYPE OF SECURITY, 2004-2011, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance

Asset finance increased from $139 billion in 2010 to $164 billion last year. Over the 2004-11 period, its compound annual growth rate has been 33% worldwide.

There are three main categories of asset finance. The first of these is on-balance-sheet finance, typically by utilities, in which the corporate entity borrows money and then deploys the proceeds on its investment programme, including new projects. The second, project finance, involves equity and

"non-recourse" debt being provided to the project itself, not to an owning corporation.

The third, labelled "bond/other" in Figure 33 includes bond finance for projects, and leasing, in which a bank will pay for, and own, the renewable energy equipment and the project owner will pay an annual fee for using it.

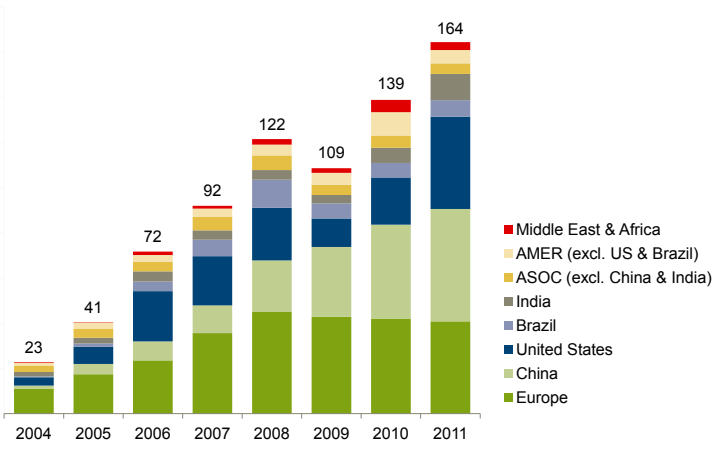
The mix between these three forms of finance has changed over the years, with project finance seeing its overall share drop from 38% in 2008 to 24% in 2009, as the credit crunch affected banks' ability to lend long-term. However this proportion recovered to 31% in 2010, and rose to a record for the last eight years of 41% in 2011, helped by the debt packages put together for several big solar and wind projects in the US. With banks once again facing increases in their costs of funding in late 2011 and early 2012, it may be difficult for project finance to repeat last year's high figure.

The bond/other category has seen its overall share edge up, from $700 million in 2009, to $2 billion in 2010 and $4.5 billion in 2011. This reflects mainly the fact that leasing has become a more popular option for financing projects, particularly those at the smaller end of the range and those in southern European countries, where bank debt became expensive or unavailable in late 2011.

Figure 34 shows that the three principal areas for asset finance in renewable energy last year were China at $49.7 million, the US at $40.9 billion and Europe at $40.8 billion. The European element saw a small decrease from 2010, and the China share a rise of 20%, but the most spectacular growth came from the US, which raised its contribution by 96% from $20.9 billion in 2010.

Many of the large projects getting the go-ahead in the US in 2011 benefitted from either the Federal 1705 loan guarantee programme, which expired at the end of September, or the Treasury 1603 grant programme, which expired at the end of December. Of the 10 largest renewable energy projects reaching the investment decision stage last year, no fewer than seven were in the US.

FIGURE 34: ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2011, $BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

These included the NRG Energy Project Amp PV plant, with a capacity of 885MW and financed to the tune of $2.5 billion, with the help of a $1.4 billion loan guarantee from the US Department of Energy in summer 2011. The project will see rooftop solar arrays put on 750 Prologis warehouses in 28 US states and the District of Columbia. Just behind in terms of size was the $2.3 billion financing of the 647MW Desert Sunlight PV project in California by NextEra Energy Resources and GE Energy Financial Services. That deal went through in September with the help of another Federal loan guarantee.

Solar thermal also saw big projects financed in the US. The 392MW Ivanpah solar thermal electricity generation portfolio in California received finance in April 2011 from BrightSource, NRG Energy, Google and the Bechtel Group. The total value of the project is $2.2 billion, it also got a Federal loan guarantee, for $1.6 billion. Other STEG plants that got the financial go-ahead were Abengoa's 280MW Solana parabolic trough project in Arizona in April, and its 250MW Mojave unit in California.

Wind financings were much less conspicuous than solar in the US in 2011, the biggest being the 419MW BP Flat Ridge wind farm phase two in Kansas, closed at $800 million in October 2011. The largest in biofuels in the US was the Abengoa Hugoton next-generation bioethanol plant for $550 million.

In Europe, the largest financings were in offshore wind, and three of these made it into the top 10 deals worldwide. These were the 400MW Global Tech 1 project off the coast of Germany, at $2.8 billion, the 400MW Djursland Anholt project off Denmark, at $1.8 billion, and the 288MW Meerwind Sud und Ost project phase one, off Germany, at $1.8 billion. In the case of Global Tech, the providers of debt were the European Investment Bank and four commercial lenders – Dexia Credit Local, KfW IPEX-Bank, Norddeutsche Landesbank Girozentrale and Societe Generale. The project is owned by Stadtwerke Muenchen and a number of other utilities and investors.

Europe also showed a smattering of project deals in other sectors. In biomass-to-power, the largest was the RWE Tilbury biomass conversion project, worth just over $1 billion for 750MW. In solar thermal, the most eye-catching deal was for the Nextera Termosol undertaking in Spain, worth $1.2 billion for 100MW, while in PV, it was the Eaga Nottingham portfolio of 30,000 rooftop solar units managed by social housing groups. It amounted to 100MW in capacity and $475 million in value.

In onshore wind, EDP Renovaveis or Portugal's Eneop-Eolicas business financed $526 million worth of projects totalling 376MW, with help from the European Investment Bank.

China's heavy asset financing programme of 2011 was dominated by wind, which amounted to $28.2 billion after adjusting for re-invested equity, but solar was also important, at $11.4 billion. Most of this consisted of small and medium-sized deals, rather than the US-type billion-dollar transactions. Among the largest Chinese financings however were the Hebei Construction Laoting Putidao wind farm, worth $909 million for 300MW; and the CPI Geermu STEG plant in Qinghai, worth $478 million for 100MW.

Other parts of the world also made important contributions to the world asset finance total, India for instance seeing a 74% jump to $11.6 billion, and Brazil a 13% increment to $7.3 billion. Featuring in the Indian total was the Mahagenco Sakri PV portfolio phases one and two in Maharashtra, worth $527 million for 125MW. In the Brazilian total, one of the leading transactions was the $519 million financing of the Impsa Ceara wind auction 2009 portfolio, totalling 211MW.

The dominance of wind and solar in overall renewable energy financing last year is highlighted in Figure 35. However each of the two leading sectors was interesting at the detailed level – offshore wind was important to the wind total, contributing six transactions that were worth more than the largest single onshore deal; and some $15 billion of the overall solar figure reflected just the largest 17 solar thermal financings.

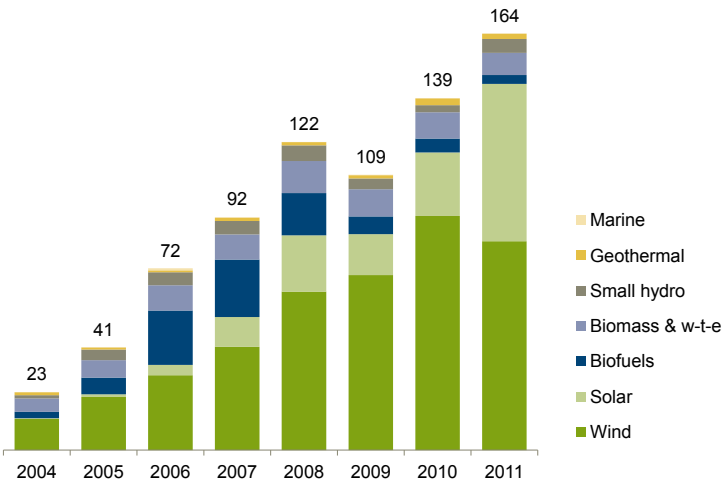
Overall, wind asset finance slipped 11% to $82.4 billion in 2011, dampened by uncertainty over policy support in Europe and the US, and competition from cheap gas-fired generation projects. Among the significant wind financings not so far covered in this chapter, the Jadraas wind farm in Sweden, developed by Arise Windpower and Platina Partners, received a commitment of $454 million for its 198MW. In Quebec province of Canada, the Lac Alfred wind farm secured $420 million for 300MW; and in Australia, the Musselroe wind farm in Tasmania landed $410 million for 168MW.

Solar asset finance jumped 147% to $62.1 billion, propelled higher by the record-scale financings in the US. However there was also a broadening in the geographical reach of large-scale solar, affecting countries such as Morocco and Peru as well as the leaders of the last few years, Germany and Italy.

Among the projects not yet mentioned that secured finance during the year were the 125MW Masen Ouarzazate STEG plant phase one in Morocco, the 77MW Nuova Rete Solare PV portfolio in Italy, the 80MW CECIC Sheyang PV plant phase two in China, and the 60.4MW FinowTower PV plant phase two in Germany. The newest name on the list was Peru, where the T-Solar Reparticion & Majes PV portfolio, totalling 44MW, secured financing of $165 million.

The only other renewable energy sector to show growth in asset finance in 2011, apart from solar, was small hydro – with a jump from $2.8 billion in 2010, to $5.4 billion. The biggest contributors to this were China, with an estimated $2.9 billion, Brazil at $900 million and India at $600 million[20].

FIGURE 35: ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2011 $BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

Biofuels asset finance fell from $5.4 billion to $3.5 billion in 2011, while that for biomass and waste-to-power declined from $10.4 billion to $8.8 billion. The biofuels total was affected by the fact that both the US and Brazilian first-generation ethanol markets had sufficient supply to meet current needs. Two transactions last year not yet mentioned were the Darling & Valero Norco biodiesel hydro-treatment plant in the US, and the ASB Hong Kong biodiesel plant. They secured financing of $408 million and $164 million respectively. In biomass, the American Renewables Gainesville plant secured $500 million for its

[20] The Chinese government has published high figures for small hydro capacity additions in 2011, without giving any details. These are being investigated but at the moment are not reflected fully in the 2009, 2010 and 2011 asset finance figures in the Global Trends report.

100MW, while the Shenzhen Energy Laohukeng waste-to-energy plant phase two landed $224 million for its 60MW.

Geothermal asset finance slipped from $2.7 billion in 2010 to $2.1 billion in 2011. The relatively few deals in this sub-sector were spread between Indonesia, New Zealand, the US, Germany and the Philippines. The largest was the $575 million financing of the 150MW Pertamina Ulubelu & Lahendong projects in Sumatra.

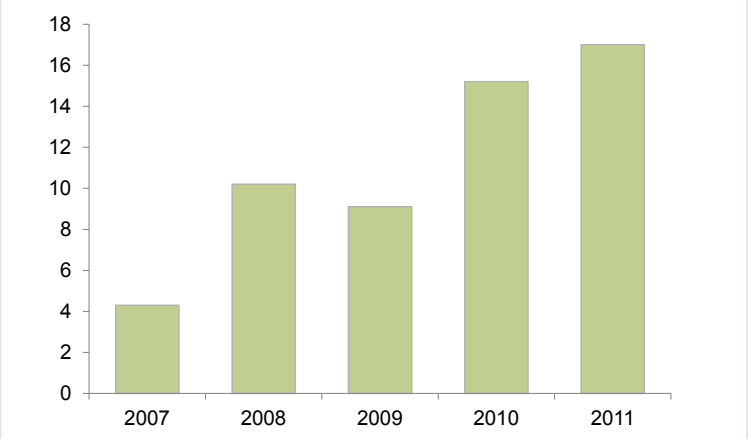
DEVELOPMENT BANKS

Multilateral and national development banks continued to be important contributors to renewable energy asset finance in 2011. Provisional data collected by Bloomberg New Energy Finance from projects on its database suggest that these institutions provided $17 billion of finance for renewable energy last year.

Figure 36 shows that this would be the largest commitment yet, beating the previous record of $15.2 billion in 2010 and – perhaps most strikingly – amounting to four times the figure reached in 2007. The two biggest providers of finance among the development banks in 2011 were the European Investment Bank with $4.8 billion, and Brazil's BNDES, with $4.6 billion.

Development banks, as in 2009 after the financial crisis, are assuming even greater importance for the renewable energy sector in light of the cost-of-funding and regulatory issues curbing the lending of private sector commercial banks. Among the other development banks that are particularly active in the sector are Germany's KfW Bankengruppe, the World Bank's International Finance Corporation, the European Bank for Reconstruction and Development, and the China Development Bank. Several countries, including the UK with its Green Investment Bank and Australia with its Clean Energy Finance Corporation, are planning to launch their own national lenders to try to spur on renewable power and energy efficiency deployment.

FIGURE 36: DEVELOPMENT BANKS: FINANCE FOR RENEWABLE ENERGY PROJECTS, 2007-2011, $BN



Source: Bloomberg New Energy Finance

LARGE HYDROPOWER

Total world hydro-electric capacity was just over 1TW in 2009, according to the International Energy Agency's World Energy Outlook 2011. This made it by far the largest type of renewable power by installed capacity, much of it dating back decades. However, hydropower projects of more than 50MW are not included in the main figures in this report, due to the questionable social and environmental impact of some large schemes.

Research by Bloomberg New Energy Finance on 103 large hydro projects suggests that only around 15GW of new capacity was commissioned in 2011, below that in 2010 and some other recent years. However statements from leading turbine makers such as Voith, Andritz and Alstom suggest that order in-take picked up in 2011. Their comments appear consistent with a return to 20GW-plus per year of hydro commissioning in 2012 or 2013. A fraction of this would be small hydro, but the lion's share would be projects of more than 50MW.

Large hydro costs on average about $1.7 million per MW, comparable to wind and cheaper than solar. It has the advantage over those technologies of having a higher average capacity factor (the amount of power hydro projects produce in on average in an hour compared to their their nameplate capacity is likely to be 60% or more for hydro, against 20-30% for wind and 15-20% for PV).

Among the large hydro projects that saw fresh capacity come online in 2011 was the first 300MW phase of the 2.4GW Bakun Dam in Malaysia. Among financings, in October, Ethiopia said it planned to increase bond sales to finance its 5.25GW Grand Ethiopian Renaissance dam project under construction on the Nile. In May 2011, the World Bank said it would lend Vietnam $330 million for the construction of a 260MW hydropower project in Thanh Hoa province, with the Vietnamese authorities contributing a further $81.7 million.

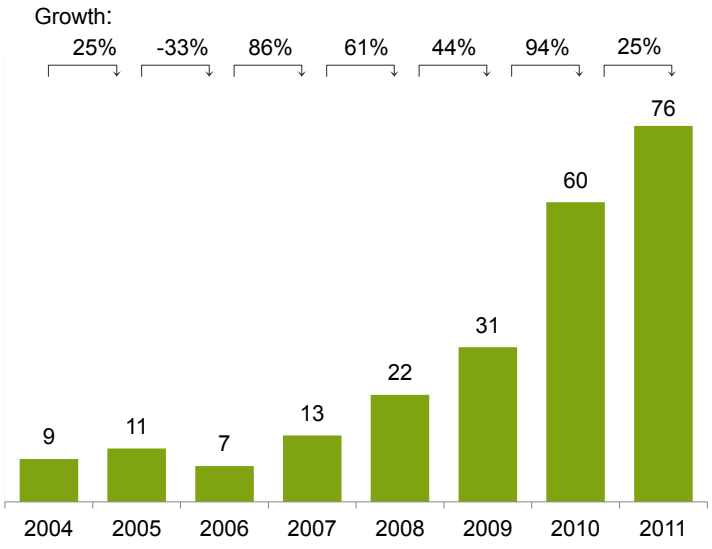
SMALL-SCALE PROJECTS

- Small-scale projects attracted $76 billion of investment worldwide in 2011, up a quarter from the $60 billion spent in 2010.
- As a proportion of overall investment in renewable energy, small-scale projects accounted for 30% in 2011, compared to 27% in the previous year and 19% in 2009.
- Germany and Italy dominated small-scale project investment in 2011 once again. On this occasion, Italy trumped its rival with $24.1 billion, compared to $20 billion.
- Japan, the US, Australia, the UK and France also saw significant investment in small-scale PV, their totals ranging from $8.1 billion down to $2.7 billion. The UK saw the fastest percentage growth, to $3.8 billion, its government under-estimating demand for small-scale PV under its feed-in tariff.
- Solar water heating continued to be a solid area for activity, particularly in China. More than $10 billion is likely to have been spent on new capacity in 2011.

Projects of less than 1MW capacity have become increasingly important in the renewable energy sector over recent years, as the cost of solar panels has come down. Businesses and consumers in many countries have identified an opportunity to make an economic return by installing PV, particularly on rooftops.

Small-scale PV power can provide two benefits - reducing overall electricity bills for the consumer and, in countries offering feed-in tariffs for solar power released to the grid, the chance to sell electricity for attractive prices. As costs of PV modules have fallen sharply, by about three quarters since mid-2008 to $1-1.20 per Watt by the end of 2011, the number of countries offering at least one of those opportunities has increased.

FIGURE 37: SMALL DISTRIBUTED CAPACITY INVESTMENT, 2004-2011, $BN

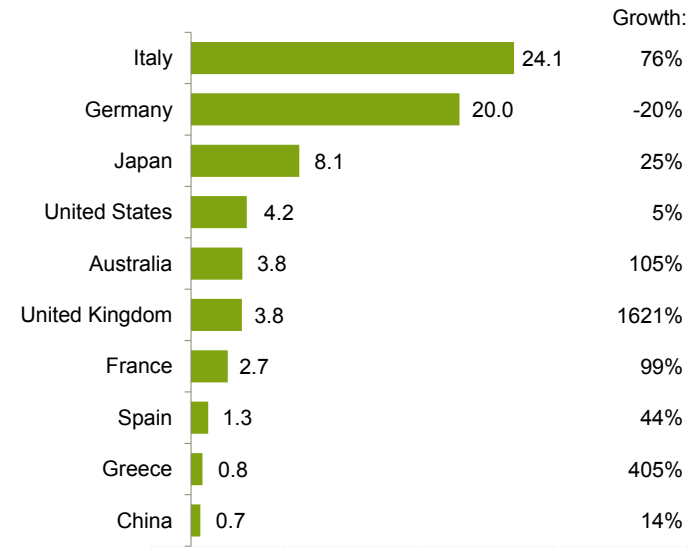


Represents investments in solar PV projects with capacities below 1MW.
Source: Bloomberg New Energy Finance

Figure 37 shows that small-scale project spending worldwide has climbed rapidly from just $9 billion in 2004, via $22 billion in 2008, to a record $76 billion in 2011. As a proportion of overall investment in renewable power and fuels worldwide, it has increased from a low of 7.2% in 2006 to a new high of 30% in 2012.

The latest rise in dollar outlays on small-scale PV is particularly impressive given that photovoltaic modules fell in price by around 50% during 2011. The reduction in overall

FIGURE 38: SMALL DISTRIBUTED CAPACITY INVESTMENT BY COUNTRY, 2011, AND GROWTH ON 2010, $BN



Top 10 countries. Represents investments in solar PV projects with capacities below 1MW.

Source: Bloomberg New Energy Finance

system costs for rooftop and other small PV units was not quite as sharp as this - since balance-of-plant and installation costs did not drop nearly as much. Nevertheless, out of 28GW of PV capacity installed worldwide in 2011, just over 21GW was in the sub-1MW category.

Buyers of these small-scale systems benefitted from falling installation costs, and therefore from reduced costs of generation over the lifetime of the project.

Figure 38 shows that in 2011, investment in small-scale projects remained concentrated in a relatively small number of countries. The two leading players, as in 2010, were Italy and Germany, both countries offering generous feed-in tariffs to investors. Italy led the way last year with $24.1 billion of small-scale project spending, up 76%, while Germany saw a decline of a fifth to $20 billion. In third place was Japan, with $8.1 billion, up by quarter. The sharpest percentage growth among the leading countries came in the UK, with a 17-fold rise to $3.8 billion, as businesses and homeowners rushed to take advantage of a feed-in tariff that was set at a time when PV prices were significantly higher than they were by mid-to-late 2011. As a result, project returns looked highly attractive, especially to those in the south of England with spare, flat ground or south-sloping roofs.

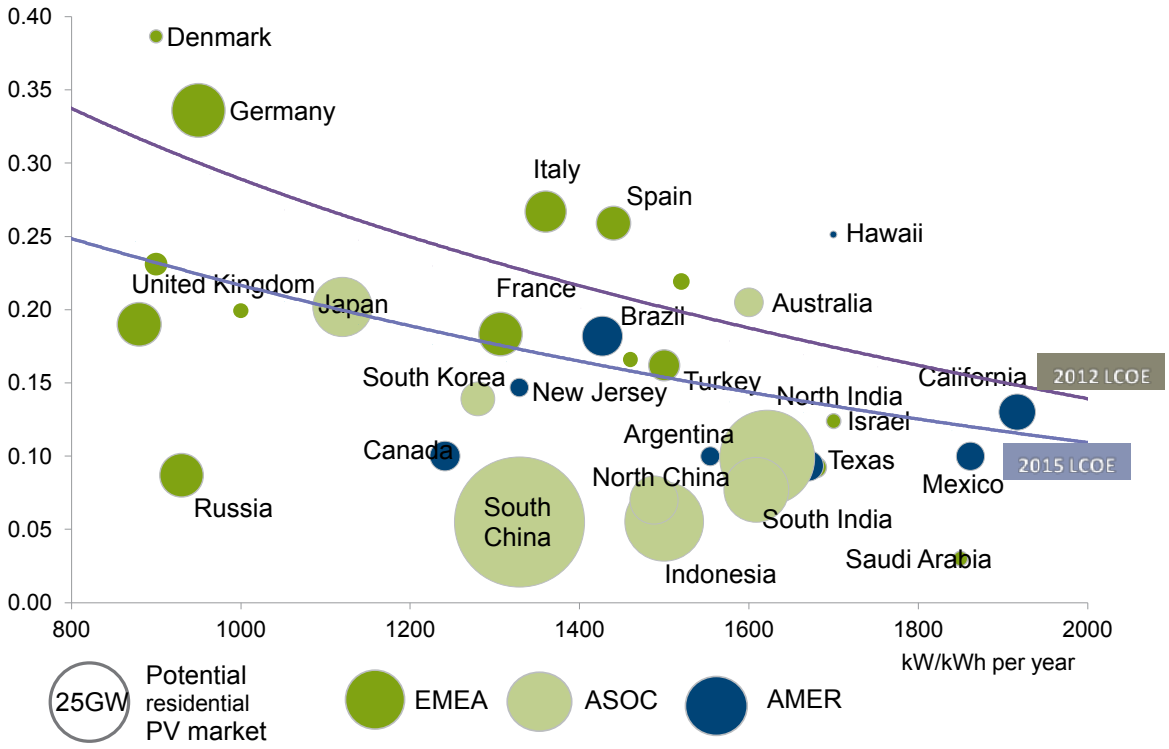
Booming installation of small-scale PV led to intense pressure on policy-makers to cool demand in countries with feed-in tariffs, for two reasons. One was that it was politically awkward at a time of economic austerity if developers were seen to be making hay on the back of generous subsidies. The other was the future cost burden - feed-in tariffs guarantee a particular selling price for electricity into the future, so the higher the capacity added, the higher the addition to consumer bills in the years ahead.

In Italy, for instance, the fifth Conto Energia programme, to be implemented in the second half of 2012, is due to introduce tariff cuts of 35% for ground-mounted PV installations and 40% for rooftop systems. The Italian government has set a EUR 7 billion cap on the amount it wants to spend per year on PV feed-in tariffs in the future, and has also proposed limits on all types of installation eligible for tariff support - other than the sub-12kW residential category.

In Germany, plans announced in February 2012 proposed subsidy cuts of up to 29% for rooftop PV from 1 April, and there will be further monthly cuts thereafter, their size dependent on whether the country's solar capacity expands by more than the government's target. There is likely to be strong small-scale PV activity in Germany in the first half of 2012 as developers rush to install before those deadlines.

Apart from Italy and Germany where the tail-end of the recent boom is likely to play out, one of the stronger small-scale PV markets in 2012 is likely, once again, to be Japan. There was just over 1GW of residential PV power installed there in 2011, and this is forecast to rise to about 1.5GW this

FIGURE 39: ESTIMATED RESIDENTIAL PV PRICE PARITY IN 2012 AND 2015, $ PER KWH



LCOE based on 6% weighted average cost of capital, 0.7%/year module degradation, 1% capex as O&M annually. $2.65/W capex assumed for 2012.

Source: Bloomberg New Energy Finance

year. Households benefit from capital expenditure subsidies at the national, prefectural and municipal levels covering up to 40% of system costs. Japan is also due to introduce its own renewable energy feed-in tariff in July 2012, providing a likely boost for the small-scale commercial PV market.

While residential PV tends to take the limelight, small-scale commercial PV is at least as important in many countries (excluding Japan). Bloomberg New Energy Finance estimates that 50% of all PV capacity added last year worldwide was small commercial of between 20kW and 1MW, compared to 25% for residential sub-20kW.

Many of the commercial-scale systems do not make headlines. However among those that did in 2011 were Gehrlicher Ecoluz Solar do Brasil's plan to install panels with capacity of 403kW on the Pituacu soccer stadium in the northeastern Brazilian state of Bahia; and a 500kW installation on warehouse roofs in Suffolk, England, by Going Solar. There were some programmes launched to help fund business-scale units, including one from the European Investment Bank and the Languedoc-Roussillon region in April 2011 - to contribute to EUR 400 million ($520 million) of investment in PV in southern France. The aims of that initiative included boosting development of installations up to 100kW on the premises of businesses, local agencies, farms and associations.

The transformed cost-competitiveness of PV power, at least in relation to retail electricity prices, should support demand this year and next, even as subsidy support fades. By early 2012, according to Bloomberg New Energy Finance analysis, the "levelised" cost of electricity from PV

in several countries (including Denmark, Germany, Italy, Spain, Australia and Brazil) was below the local retail electricity price (shown on the X axis on Figure 39). This made it economic to install PV panels to generate at least a proportion of a user's own power needs. With PV prices expected to fall further, Figure 39 shows that a lower LCOE should mean that the same becomes the case in a number of other countries by 2015 - including Turkey, France, Japan and parts of the US.

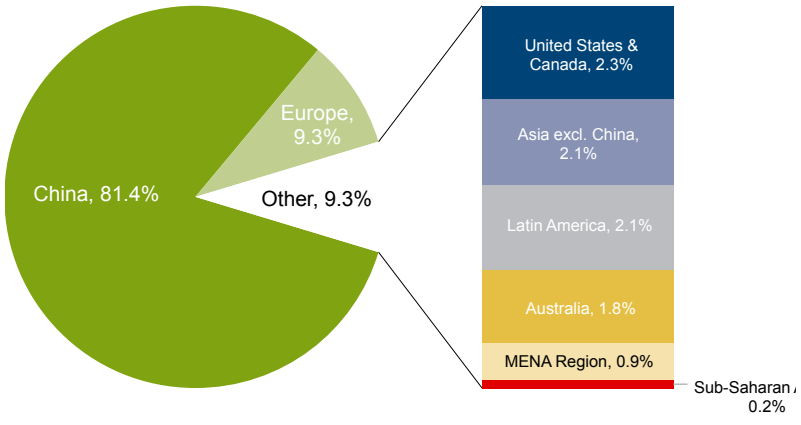
SOLAR WATER HEATERS

By the end of 2010, the total cumulative capacity of solar thermal collectors in operation worldwide was 195.8GWth, which represented 279.7 million square meters, according to the International Energy Agency. These devices consist of different types, glazed water collectors (flat plate and evacuated tube), unglazed water collectors and unglazed and glazed air collectors. Of these, glazed solar water collectors accounted for 173.1GWth. The remaining 22.8GWth comprised unglazed water collectors, which are designed to heat swimming pools, and glazed and unglazed air collectors, which heat air using solar energy.

A total capacity of 42.2GWth, corresponding to 60.2 million square meters of solar thermal collectors, were newly installed worldwide in 2010, an increase of 14% compared to the previous year, the IEA estimates. The dominant markets for solar collectors in terms of newly capacity installed in 2010 were China and Europe, which accounted for 34.30GWth and 3.93GWth respectively, in total 94.7% of global new collector installations in 2010.

Asia, specifically India and China, enjoyed the highest growth rates in terms of new capacity. The US and Canadian markets enjoyed an increase of 16% in 2009-2010. European markets saw a dip for the second consecutive year, falling 7.5% in 2009-2010, according to the IEA. The size of investment worldwide is hard to estimate because the price of devices varies hugely, but it is likely to have been more than $10 billion.

FIGURE 40: GLOBAL INSTALLATIONS OF GLAZED WATER COLLECTORS BY REGION, 2011



Source: International Energy Agency

Solar water heaters are systems that produce heat – not electricity – as an end-product. A solar water heater uses the energy from the sun to pre-heat water before it enters a conventional gas/electric heater. A typical system consists of a water storage tank and one or more solar collectors.

PUBLIC MARKETS

- Public market investment in renewable energy fell 10% to $10.1 billion in 2011, amid general investor unease over economic prospects, and specific concern about changes in clean energy support policies and over-capacity in the renewable power supply chain.
- The WilderHill New Energy Global Innovation Index, or NEX, slumped 40% last year, at one point touching its lowest level since 2003, while the Nasdaq and S&P 500 ended 2011 almost exactly where they started.
- The main reason for the under-performance of renewable energy stocks was severe pressure on solar and wind manufacturers, driven by overcapacity, falling product prices, competition from Asia, and reduced subsidies in many European countries.
- Investment volumes were again dominated by wind and solar, which each raised more than $4 billion on public markets during 2011. That represented a 2% fall for wind and a 23% decline for solar. Investment fell hardest in small hydro, down 57%, and biomass and waste-to-energy, down 46%.
- Two brighter spots were biofuels, up 37% at $654 million, and geothermal, up almost fivefold to $406 million.
- China continued to dominate new share issues, with fundraising concentrated on Far Eastern exchanges.

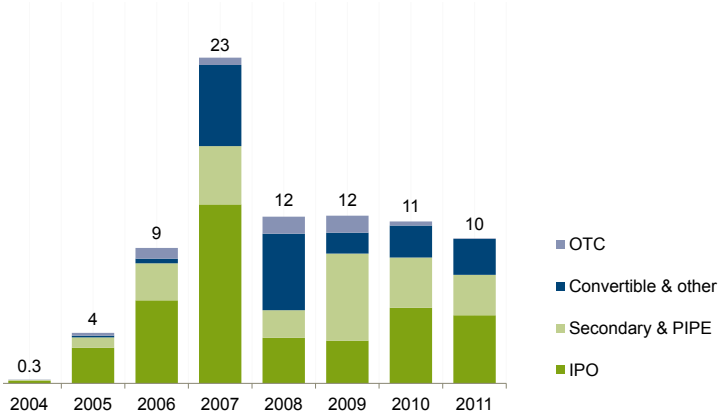
Renewable energy share prices had an exceptionally poor year in 2011. Unsurprisingly, this had a dampening effect on the amount of money specialist companies managed to raise in new equity from stock market investors.

By the end of 2011, renewable energy companies had raised less money than in any year since 2006, and less than half the total in 2007 (see Figure 41). To the nearest $100 million, the 2011 total was $10.1 billion, some $1.2 billion lower than in 2010, and less than half the $22.7 billion peak established in 2007. Renewable energy companies were beset by fierce competition from China, "green austerity" in the West, and historically low US natural gas prices. Rare moments of optimism (such as in March and April 2011) were swiftly dashed, and there were high-profile casualties in wind and solar.

Figure 41 also shows the split between different types of fund-raising – including initial public offerings, secondary and private investment in public equity (PIPE) deals, and convertible and other issues. The proportions of each remained similar to those in 2010, with IPOs accounting for the largest share of money raised.

Investment volumes started the year respectably enough given the difficult economic backdrop, and by the end of the first quarter, conditions seemed to be improving. Renewable energy share prices soared in the second half of March, as investors recoiled from nuclear in the wake of the Fukushima disaster in Japan, and as the Libyan crisis sent oil prices surging. Public markets equity-raising rose from $3.8 billion in the first quarter to $4.1 billion in the second.

FIGURE 41: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2004-2011, $BN

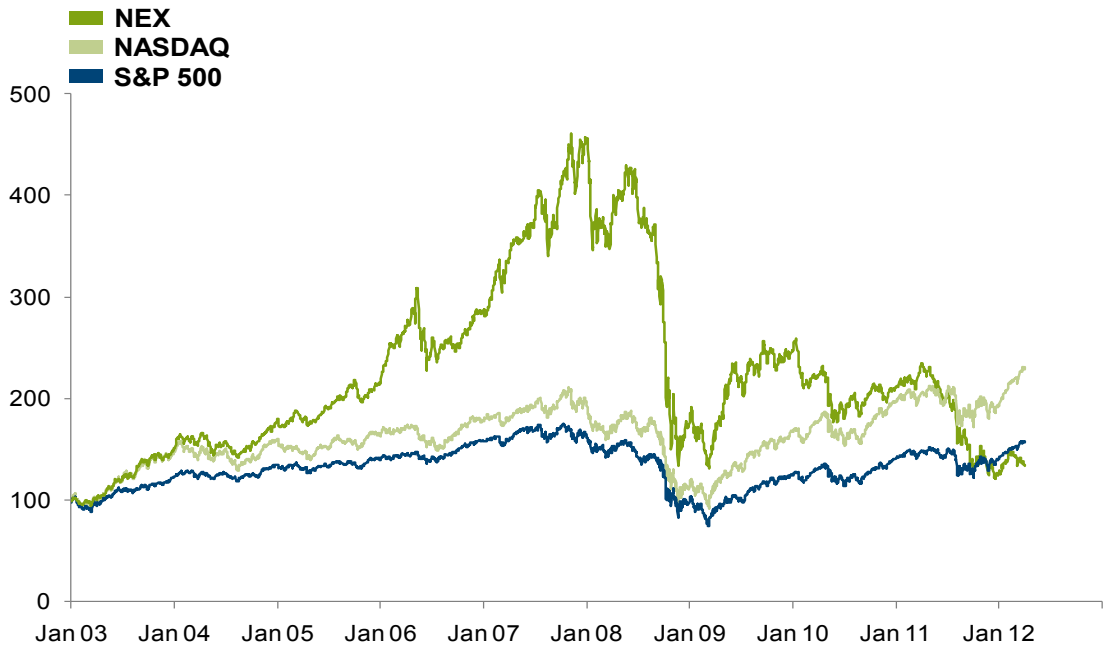


PIPE = private investment in public equity, OTC = over-the-counter.
Source: Bloomberg New Energy Finance, UNEP

But sentiment soon soured, over-powered by the worsening euro area crisis and the reduction of renewable energy subsidies in several European countries in response to economic austerity. The NEX index, which had jumped 10% in the early part of the year, went into steep and largely uninterrupted decline for the rest of 2011, as shown in Figure 42. The performance of the NEX relative to broader stock market indices also deteriorated, as shown in Figure 43. Fundraising slumped to $1.3 billion in the third quarter, and in the fourth, to $870 million. That was a quarterly level not seen since early 2009, when markets were paralysed by the possibility of a banking collapse, or the last quarter of 2005, when the sector was at a much earlier stage in its growth.

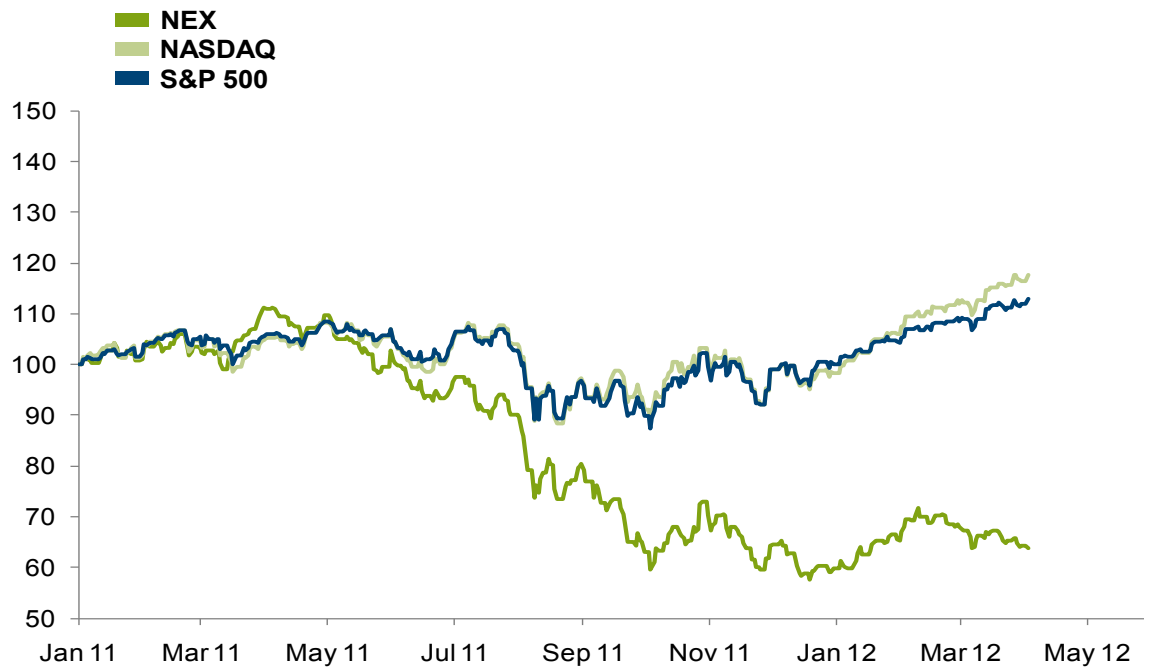
Investment volumes were again dominated by wind and solar, which each raised more than $4 billion during 2011 (Figures 44 and 45). That represented a 2% fall for wind and a 23% decline for solar. The two sectors faced similarly difficult conditions, including massive overcapacity, fierce competition and plunging product prices. In solar, the price of PV modules, which peaked in 2008 at around $4.20 per Watt, started 2011 at $1.80/W and ended the year at $1/W. For wind, turbine prices averaged EUR 0.92 million ($128 million) per MW, down 11% on 2010 in euro terms and 24% lower than their peak in 2009.

FIGURE 42: NEX VS SELECTED INDICES, 2003 TO 2012



Index values as of 2 April 2012; Nasdaq and S&P 500 rebased to 100 on 1st January 2003.
Source: Bloomberg New Energy Finance

FIGURE 43: NEX VS SELECTED INDICES, 2011-2012

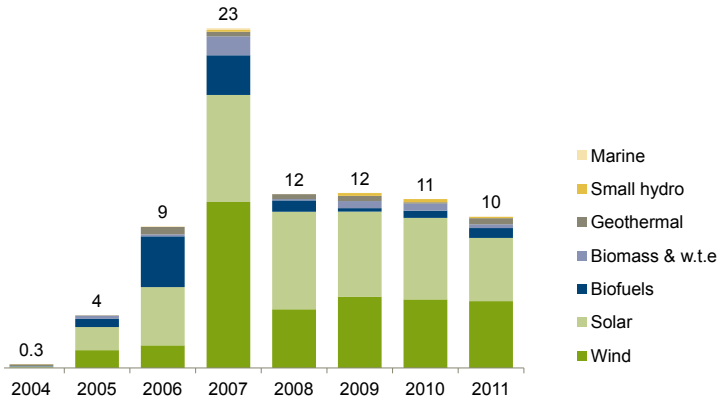


Index values as of 2 April 2012; Nasdaq and S&P 500 rebasedto 100 on 1st January 2003.
Source: Bloomberg New Energy Finance

Plunging hardware prices encouraged countries to curtail support for renewable energy, partly as a way of shielding hard-pressed consumers from further electricity price rises, and partly as a way of trying to prevent project developers making excessive returns on the back of tariffs that were set when technology prices were higher.

The trend for reductions in support had begun in 2010. By the end of that year, Spain had announced retroactive cuts to its feed-in-tariffs for established PV plants, and the Czech Republic had put a retroactive tax on PV projects. No other retroactive cuts took place in 2011, but Germany, Italy and the UK were among those announcing cuts in support for future projects. In the US, the Federal loan guarantee scheme expired at the end of September, and the Treasury grant programme followed at the end of December. In addition, government R&D spending fell, especially sharply in Asian countries such as Japan and Korea, as green stimulus packages announced in 2008-09 started to run out of steam.

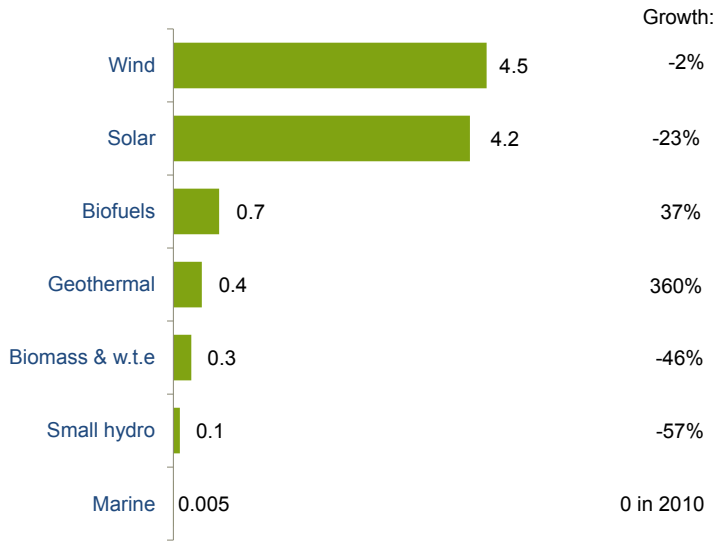
FIGURE 44: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2011, $BN



Source: Bloomberg New Energy Finance, UNEP

In the circumstances, bloodletting across the sector was inevitable. In solar, the collapse of thin-film panel manufacturer Solyndra, which had received a $528 million Federal loan guarantee, was only the most high-profile insolvency. Evergreen

FIGURE 45: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2011, AND GROWTH ON 2010, $BN



Source: Bloomberg New Energy Finance, UNEP

Solar, SpecraWatt, Solar Millennium and Solon were also casualties. There were job cuts at many manufacturers, including First Solar, American Superconductor and, in January 2012, Vestas Wind Systems. Vestas, the world's leading turbine maker, saw its share price fall to 92% below its 2008 peak by the end of last year.

As noted in earlier chapters, project developers gained from the same falling hardware prices that were hurting manufacturers – but developers are often unquoted companies, and even if they are quoted, uncertainty over future policy dampened their share prices too in 2011.

Figure 45 shows that despite the difficult conditions on stock markets generally, and in clean energy in particular, public markets investment in biofuels managed a gain of 37%. Biofuels reached its figure of $654 million thanks partly to a high crude oil price during the year, and some positive newsflow, including technical approval for the use in aviation of biofuels made from plant oils and animal fats. With increasing concern about the carbon emissions of some first-generation biofuels due to their indirect impacts on land use, it was second-generation technology, which does not depend on edible crops for feedstock, that dominated fundraising.

Three quarters of the investment went to just three US companies that listed on Nasdaq. Gevo, backed by Vinod Khosla and Sir Richard Branson, raised $123 million through an IPO to fund the conversion of traditional corn-ethanol plants to make isobutanol for biofuels. The company is also developing enzymes that would produce isobutanol from the cellulosic, non-food component of corn. The US Environmental Protection Agency approved Gevo's isobutanol as a transport fuel additive in 2010, but it is not yet approved for use in aeroplanes.

Solazyme, which uses genetically modified algae to produce biofuels and products for the food and cosmetics industries, raised $216 million by IPO. The algae convert simple sugars into algal oil, and are kept in darkened fermentation tanks to suppress photosynthesis and increase the efficiency of the process. At the end of the year, Solazyme won a contract to supply the US Navy with jet fuel and marine distillate fuel, starting in 2014. The

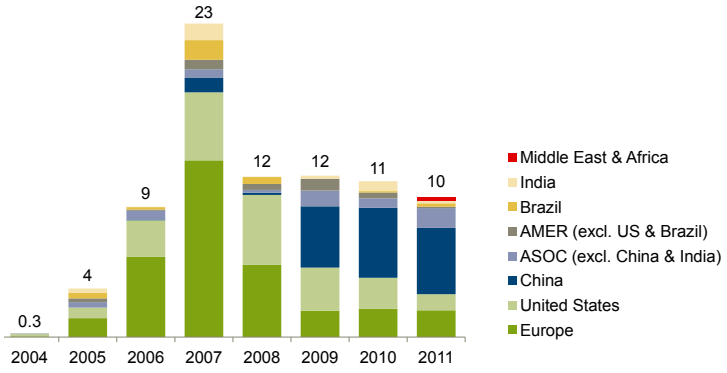
company already has a much larger contract to supply United Airlines with 20 million gallons of jet fuel by 2015.

KiOR, another company backed by Khosla, raised $162 million to build a second production plant. The company converts wood and other non-food biomass through a catalytic process into a renewable oil, which can then be refined through existing oil industry equipment. The company's first plant should produce 11 million gallons per year from the second half of 2012.

Australian and UK companies also took a significant slice of the biofuel investment, with share issues from two firms developing production of jatropha oil. UK-based Nandan Cleantec, with operations in Hyderabad, India, raised $26 million on the Alternative Investment Market, while Australia's Mission NewEnergy raised $25 million in a secondary share placement on Nasdaq.

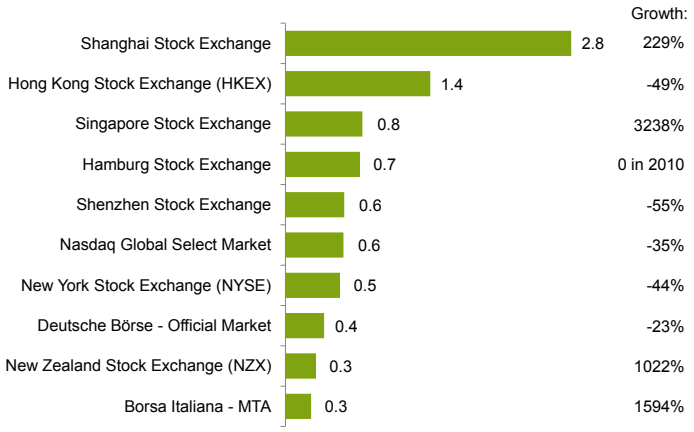
Another bright spot was the geothermal sector, where investment through public markets rose four-and-a-half times (360%) to $406 million.

FIGURE 46: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY REGION OF EXCHANGE, 2004-2011, $BN



Source: Bloomberg New Energy Finance, UNEP

FIGURE 47: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY EXCHANGE, 2011, AND GROWTH ON 2010, $BN



Top 10 exchanges.

Source: Bloomberg New Energy Finance

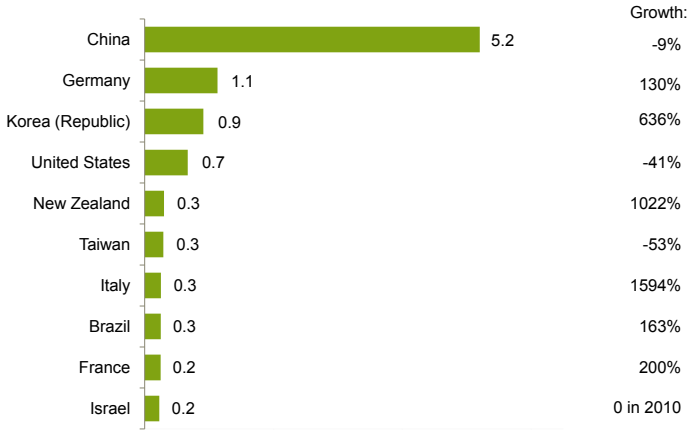
However, this was largely the result of just two transactions. Contact Energy, a New Zealand utility company, raised $277 million through a rights issue to fund the construction of a new 166MW geothermal plant north of Taupo, to be completed by mid-2013. And Ram Power of Nevada raised $73 million to fund a 72MW project in Nicaragua.

The number of IPO deals for renewable energy companies fell from 30 to 22 in 2011. Some IPOs failed, such as the attempted $250 million fund-raising from solar thermal developer BrightSource, while others, like the $74 million launch by Nexolon, South Korea's biggest manufacturer of silicon ingots and wafers, got away only by floating at a steep discount to the marketed price range.

The largest IPO fundraising came from Sinovel Wind Group, the Chinese turbine manufacturer, which raised $1.4 billion on the Shanghai Stock Exchange to fund an R&D centre in Beijing and three production plants. The second biggest was a Chinese wind project developer, Huaneng Renewables Corporation, which raised $850 million on the Hong Kong Stock Exchange.

There were also substantial IPOs from solar companies such as Beijing Jingyuntong Technology,

FIGURE 48: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY COMPANY NATIONALITY, 2011, AND GROWTH ON 2010, $BN



Top 10 Countries.
Source: Bloomberg New Energy Finance

which raised $394 million on the Shanghai exchange to fund a plant to make solar ingot furnaces and wafers, and from Sungrow Power, a Chinese manufacturer of wind and PV inverters, which raised $215 million on the Shenzhen Stock Exchange.

Chinese exchanges accounted for by far the largest part of public markets investment in 2011, at $4.8 billion, just under half the total (see Figure 46). The next highest figures were produced by European exchanges ($1.9 billion), Asian exchanges outside China and India ($1.4 billion), and US exchanges ($1.2 billion). Figure 47 provides detail on the individual exchanges that were active, Shanghai and Hong Kong taking first and second places respectively in 2011.

Given the dominance of Chinese exchanges, it is no surprise to see in Figure 48 that Chinese-domiciled companies also stood out in terms of equity-raising last year. They raised $5.2 billion, down 9% on 2010, while US firms, for instance, raised just $667 million, down 41%. The resilience of China in terms of public markets investment reflected the fact that at a time of pressure on technology prices, it was often Chinese companies that had the lowest costs of manufacture.

VENTURE CAPITAL AND PRIVATE EQUITY

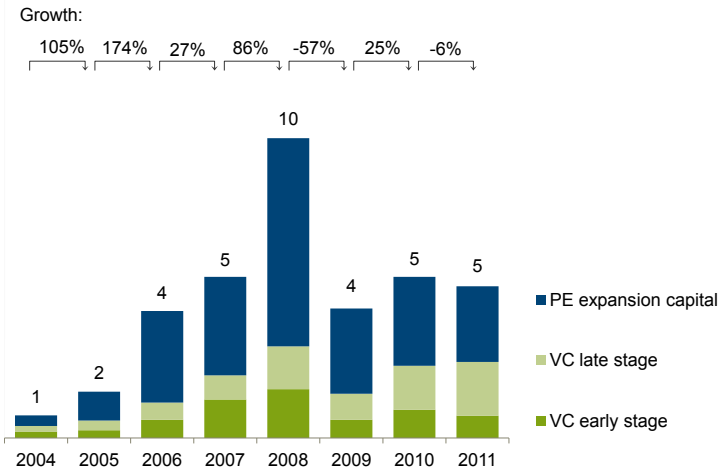
- Venture capital and private equity investment in renewable energy companies dipped 6% to $5 billion in 2011, but remained above 2009 levels. Venture capital investment rose 5% to $2.5 billion, while private equity spending fell 15% to $2.5 billion, its third consecutive annual decline.
- Within venture capital, early-stage investment dropped 21% to $734 million and late-stage leapt 22% to $1.8 billion.
- Solar remained the biggest sector for VC/PE investment, up 13% to $2.4 billion, with biofuels up 9% to $804 million. Second-generation biofuels took all but a tiny share of the VC/PE money going into that sector. Wind slumped 66% to $520 million.
- The sharpest increases were seen in biomass and waste-to-energy, where VC/PE business tripled (up 186%) to $1 billion, and geothermal, which climbed 73% to $195 million. Both were based on a small number of large deals.
- The US remained the largest country for VC/PE by far, but investment slipped 11% to $2.8 billion, while in Europe, spending rose 16% to $924 million. For growth, India was the outstanding country, jumping four-fold (up 334%) to $332 million.

Venture capital and private equity investment in renewable energy put in a resilient performance against a difficult backdrop in 2011. Investment totalled $5 billion, down 6% on the previous year, a modest fall given that 2011 saw clean energy share prices lose 40% of their value. Venture capitalists' confidence had to endure threats such as policy uncertainty in Europe, historically low natural gas prices in the US, and fierce competition from China for the solar supply chain.

In venture capital, there was a noticeable shift from early-stage to late-stage investment, the former falling 21% to $734 million and the latter jumping 22% to $1.8 billion (Figure 49). This might suggest investors are becoming more risk-averse as a result of market volatility and intense competition from China, or that the biggest renewable energy sectors are growing in maturity and producing fewer early-stage opportunities.

There is a third possibility – that VC funds continued to invest as actively in early-stage firms, but that they drove harder bargains in return for their cash. Certainly, the number of disclosed VC/PE deals in renewable energy in 2011, at 241, was

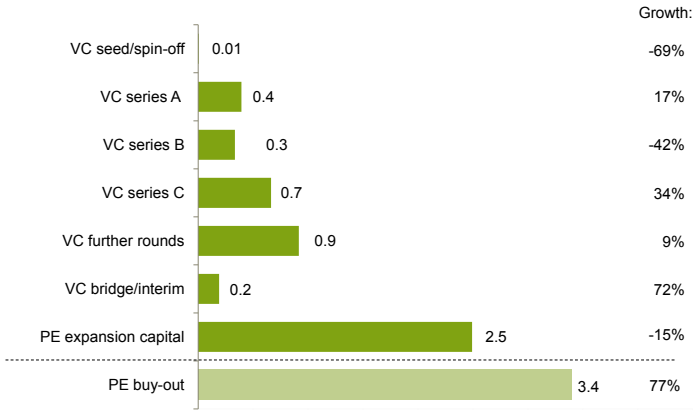
FIGURE 49: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2004-2011, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

FIGURE 50: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2011, AND GROWTH ON 2010, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

only slightly down on the record figure of 246 reached in both 2008 and 2010. Figure 50 shows that the biggest falls in deal value in money terms were in venture capital series B and in private equity expansion capital. The biggest gain was in venture capital series C transactions.

Private equity buy-outs increased by 228% to $3.4 billion, but these are assets changing hands and so are not included in the new investment total of $5 billion for 2011. See mention of the Rete Rinnovabile acquisition below and in Chapter 9.

Sentiment in VC/PE was hit by some high-profile solar insolvencies, especially that of Solyndra, whose innovative cylindrical thin-film PV proved too expensive amid plunging conventional module prices. That US company went bust after swallowing not only a controversial $528 million Federal loan guarantee, but also cumulative VC/PE investment of $1.2 billion – some of it raised just six months before it went under.

Nevertheless, solar remained the largest sector for VC/PE investment, attracting $2.4 billion of fresh capital. This was up 13% on 2010 and the highest level since 2008's record of $4.8 billion (see Figure 51).

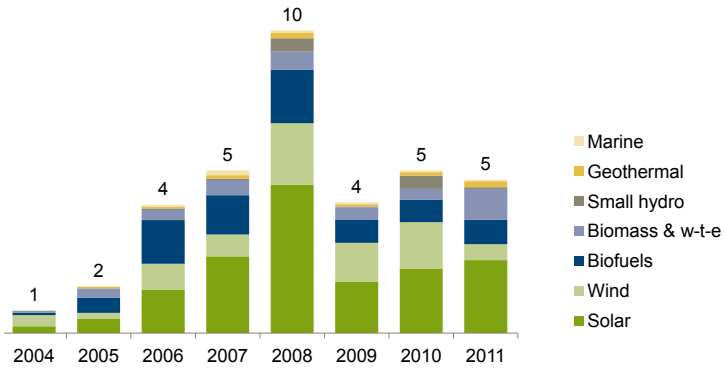
With photovoltaic equipment prices plunging, it was perhaps surprising that investment in "plain vanilla" crystalline silicon technology should double to $720 million. But nearly half of the 2011 total was due to two large deals. China's LDK Silicon & Chemical Technology raised $240 million in PE expansion capital from three Chinese development banks, and Suniva, a manufacturer of monocrystalline silicon cells based in the US state of Georgia, raised $94 million in late-stage VC funding.

In total, crystalline PV made up 30% of all VC/PE investment in solar. Other funding went to sub-sectors less exposed to falling cell and module prices, such as solar thermal electricity generation (STEG), thin-film technology, and service and support companies.

Solar thermal saw a 31% increase in VC/PE investment to $367 million, and produced the second largest deal. BrightSource Energy, the California based STEG developer, raised $202 million in late-stage VC finance, to fund 14 projects in the US and international expansion.

Thin-film technology – which is typically less efficient than crystalline cells, but lighter and often incorporated into building materials – saw VC/PE

FIGURE 51: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2011, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

investment fall 15% to $553 million. This included late-stage VC deals by Stion, which raised $130 million, and Alta Devices, $72 million.

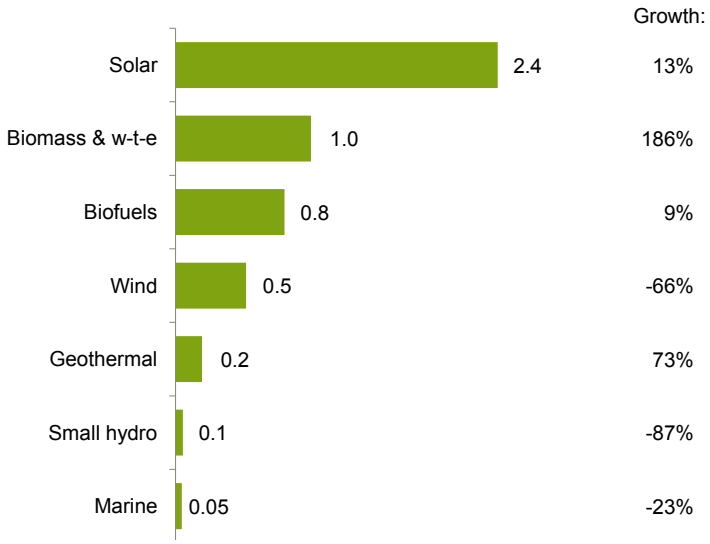
In services and support, there were deals for OneRoof Energy, which raised $50 million; for software and financing provider Clean Power Finance, which raised $25 million; and third-party finance arranger Tioga Energy, which raised $10.6 million.

VC/PE money also supported project development companies likely to benefit rather than suffer from falling equipment prices. KRoad Power, a New York-based renewable power operator, raised $40 million in private equity, and Lincoln Renewable Energy, a solar and wind project developer based in Chicago, raised $14 million. The outstanding example of this trend, but not included in the VC/PE new investment total because it was a buy-out, was the acquisition of Rete Rinnovabile, a 144MW portfolio of Italian PV farms, by the British private equity firm Terra Firma (see Mergers & Acquisitions chapter for details).

Venture capital and private equity investment in wind plunged from $1.5 billion in 2010 to $520 million in 2011 (see Figures 51 and 52), as the average deal size fell sharply. The number of deals remained steady, but the largest was valued at just $79 million. In 2010, by contrast, the biggest deal was worth $400 million, and there were three others of $100 million or more.

The fall in VC/PE investment in wind reflects well established trends within a mature sector. Most independent wind equipment suppliers have already tapped VC/PE funding or floated on public markets. At the same time, the difficulties of quoted manufacturers such as Vestas, due to industry overcapacity and falling equipment prices, inevitably mean a harsh climate for the next generation of technology developers, and investors. What is more, the great expense of wind R&D makes it more feasible for big companies to undertake than start-ups. Like solar, wind also saw strong support for service companies or project developers – companies that would positively benefit from falling equipment prices. Nowhere was this clearer than in India – the fastest growing country for total clean energy investment in 2011 - where VC/PE investment in all renewable energy sectors leapt four-fold to $332 million (see Figures 53 and 54).

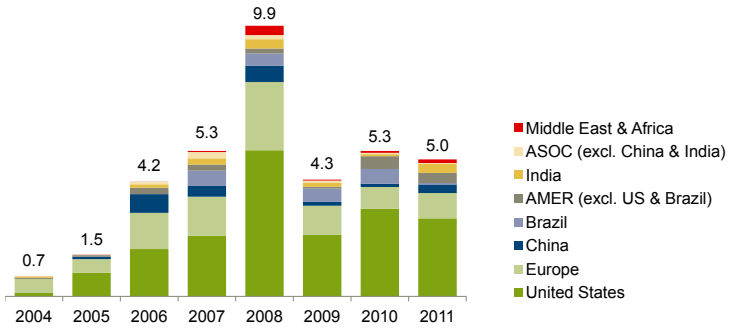
FIGURE 52: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2011, AND GROWTH ON 2010, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

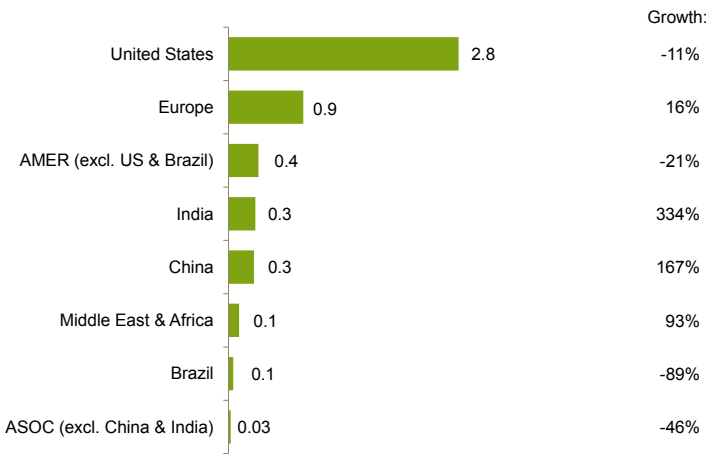
FIGURE 53: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2011, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

FIGURE 54: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2011, AND GROWTH ON 2010, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

Mytrah Energy, for example, raised $132 million to fund wind farm projects, while NSL Renewable Power, based in Hyderabad, raised $40 million. Solar developers also got in on the act, with Mumbai-based Kiran Energy Solar raising $50 million in venture capital. Mytrah said that its wind power is now cheaper than coal-fired power in India because of rising coal import prices.

With the slump in wind investment, biofuels edged into third after solar and biomass – up 9% to $804 million, just under half its 2008 peak level. But the relatively modest increase in overall investment masks two significant developments within the sector.

First, 2011 saw the complete domination of next-generation biofuels – those which do not rely on food crops for feedstock – over traditional first-generation fuels. There were 43 next-generation deals in total last year, against five first-generation deals worth less than a fortieth of the sector total. These trends have been evident for several years, but the dominance of next-generation is now total, and represents a complete inversion of the situation in 2006.

The biggest fundraising was undertaken by Sundrop Fuels, a Colorado-based company whose technology combines biomass and natural gas in an ultra-high temperature reactor to produce 'drop-in' replacement transport fuels. It raised $175 million in private equity to begin building a commercial production facility. Chesapeake Energy, the largest independent gas producer in the US, has taken a stake.

Fulcrum Bioenergy, a California-based company whose technology gasifies municipal waste to produce ethanol and other chemicals, raised $100 million of venture capital with backing from Waste Management, the largest rubbish hauler in the US. Fulcrum plans to build an ethanol production plant in Nevada that will be supplied with free feedstock by Waste Management for 15 years.

The sharpest increases in VC/PE investment came in two of the smaller sectors. Biomass and waste-to-energy nearly tripled (up 186%) to $1 billion, but this was largely due to two unusually big deals. Alinda Capital Partners bought a majority stake in the German biogas project developer, Agri.capital, for $445 million, and Plasco Energy, a Canadian waste-to-energy developer, raised $143 million in private equity.

Investment in geothermal jumped 73%, and this appeared more broadly based: there were eight deals in 2011 against just three the previous year. However, the entire increase was due to two fundraising deals by one company, Gradient Resources, a Nevada-based project developer, which garnered $101 million altogether.

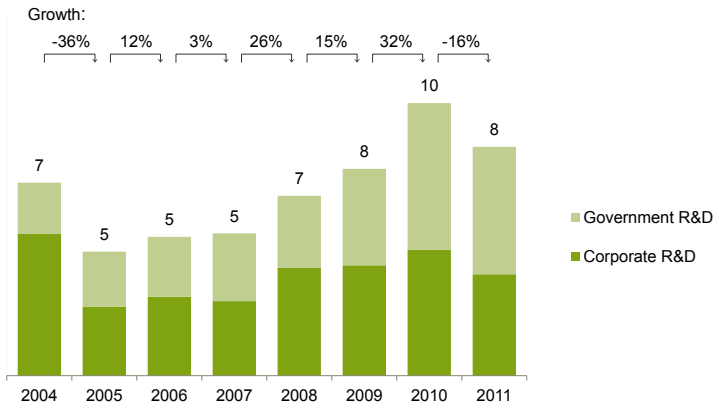
Figure 54 shows that while VC/PE investment in the US fell 11% in 2011 and that in other parts of the Americas also dipped, there were increases – albeit from a modest base – in China, India and the Middle East & Africa region. Europe also enjoyed a rise, of 16%, to $924 million.

RESEARCH AND DEVELOPMENT

- Global research and development spending on renewable energy fell 16% to $8.3 billion in 2011.
- Government R&D spending fell 13% to $4.6 billion, largely due to the unwinding of "green stimulus" programmes in Japan and Korea.
- However, government support, which outstripped company spending for the first time in 2010, maintained its lead in 2011, as corporate R&D dropped 19% to $3.7 billion.
- Solar attracted most support, claiming almost half (49%) of all R&D dollars, despite a 16% fall to $4 billion. It was followed by biofuels at $1.9 billion and wind at $1.2 billion. No sector escaped the squeeze, nor any region bar Brazil.

Research and development investment in renewable energy fell 16% during 2011 to $8.3 billion (Figure 55). The figures in this chapter are aggregated by Bloomberg New Energy Finance from its own database and the Bloomberg Terminal (for corporate R&D), and from its own database and that of the International Energy Agency (for government R&D[21]).

FIGURE 55: R&D INVESTMENT IN RENEWABLE ENERGY, 2004-2011, $BN



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

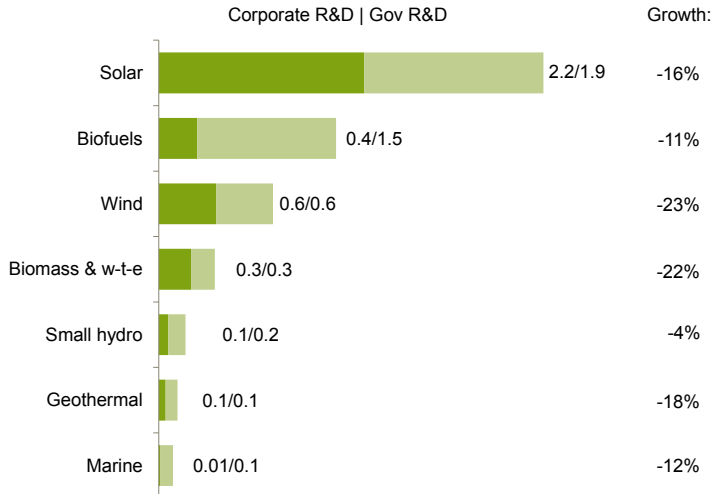
Spending declined across all technologies (Figure 56) and almost all regions – only Brazil managed a tiny increase (Figure 57). And it fell in both the public and private sectors, beset by fiscal austerity in government finances, and caution on the part of companies in the face of economic uncertainty and margin pressure in the clean energy sector. However, the news was not quite as bad as the headline figure might at first suggest.

While the squeeze was widespread, the scale of the global decline was largely explained by an investment slump in just one region. R&D spending in "Other ASOC" – Oceania and Asia excluding China and India - dropped $1.1 billion, equivalent to 70% of the global decline of $1.6 billion. This in turn was caused by sharp drops in government R&D in Korea, down 80% at $132 million, and Japan, down 61% at $212 million, as the 'green stimulus' programmes announced in 2009 began to unwind.

In every other region, government spending on renewable energy R&D rose, although not by much, still buoyed by the remaining 'green stimulus' packages. Global government R&D spending, which had doubled from $2.6 billion in 2008 to $5.3 billion in 2010, fell back to $4.6 billion in 2011, of which Bloomberg New Energy Finance estimates some $2.4 billion was due to green stimulus.

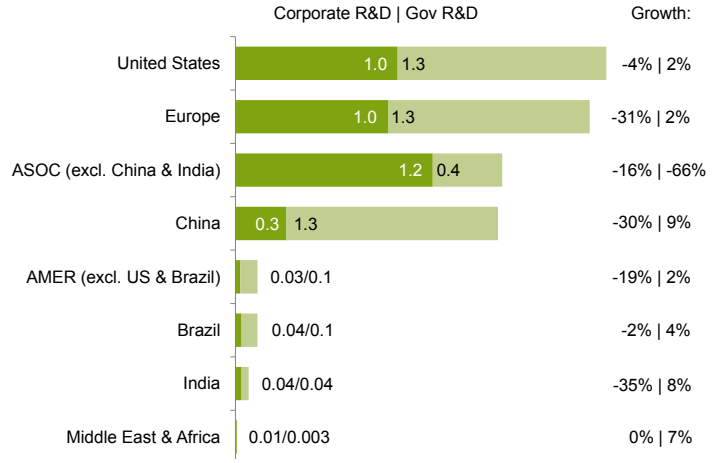
[21] International Energy Agency RD&D Statistics. See http://www.iea.org/stats/rd.asp

FIGURE 56: CORPORATE AND GOVERNMENT R&D RENEWABLE ENERGY INVESTMENT BY TECHNOLOGY, 2011, AND GROWTH ON 2010, $BN



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

FIGURE 57: CORPORATE AND GOVERNMENT R&D RENEWABLE ENERGY INVESTMENT BY REGION, 2011, AND GROWTH ON 2010, $BN



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

This stimulus support is unlikely to last much beyond 2012, as 90% of the funds are likely to have been spent by the end of the year. And neither is the outlook for corporate investment in renewable energy R&D particularly encouraging. Private sector spending fell across all technologies and all regions in 2011, down 19% to $3.7 billion, as wind and solar manufacturers grappled with overcapacity, plunging product prices and fierce competition. In solar, corporate R&D spending slipped from $2.5 billion in 2010 to $2.2 billion in 2011, while in wind, it fell from $800 million to $600 million.

Yet even at these reduced levels, it is worth noting that R&D investment in some renewable energy sectors still matches or exceeds some studies' estimates of what is needed to achieve emission reduction benchmarks. The International Energy Agency has published a report showing how much R&D investment is needed in each of the main low-carbon technologies to achieve the Agency's Blue Map scenario, in which climate emissions are reduced 50% by 2050. The report, Global Gaps in Clean Energy RD&D, 2010, concludes that for solar, annual investment of between $1.8 billion and $3.6 billion is required. In 2011, combined corporate and government R&D spending in solar was $4 billion, above the upper end of the IEA range. For bioenergy, the IEA calculated that $1.5 billion to $3 billion is needed each year, whereas $2.4 billion was invested in biofuels and biomass in 2011, within the IEA range. Only wind undershot last year: the IEA range was $1.8 billion to $3.6 billion, whereas the sector spent an estimated $1.2 billion on R&D in 2011, according to the Bloomberg New Energy Finance data used in this report.

If government R&D spending were to drop back to pre-2008 levels, and corporate R&D remained steady, total spending would still exceed IEA Blue Map targets for solar, and would remain within the range for bioenergy. However, the IEA report suggests that R&D spending on wind, and on other low-carbon technologies such as smart grid, power storage, carbon capture and storage, and advanced vehicles, all beyond the scope of this report, are still far below the necessary levels. Many others would also point out that a 50% emissions cut by 2050 may be

too little, too late to prevent temperatures rising more than 2 degrees Centigrade.

Investment in solar research and development fell 16% to $4 billion during 2011, but the sector maintained its dominance of renewable energy R&D overall, claiming almost half (49%) of all dollars invested, and more than twice that of the next largest sector. Government spending on solar R&D shrank principally because of the decline in Japan and Korea, while corporate investment fell because of major reductions in those countries and Europe, as big manufacturers retrenched, and as BP pulled out of the sector altogether.

Research priorities in solar remain – such as to improve the energy output of photovoltaic cells, and to raise the resource and cost efficiency of production processes. In silicon-based PV, one task has been to improve the crystallisation of silicon ingots – the blocks of material from which cells are cut. Multicrystalline ingots are quicker and cheaper to produce but make less efficient cells, and monocrystalline ingots are higher performing but take longer to cast. A number of manufacturers including China's GCL-Poly are developing 'mono-like' ingots that combine the benefits of both.

Another development has been the adoption, by LDK and others, of diamond wire saws that slice the ingots more thinly, making the silicon go further. However, wafers are more likely to be scratched using this method, and finding solutions to this is the subject of further research.

In thin-film PV, the focus remains to deposit the semiconductor layer on its substrate more quickly and more evenly, and so reduce costs. Solar Frontier, First Solar and General Electric subsidiary Primestar Solar are among those most active in this work.

Government-funded R&D is also directed at cutting solar costs. For example, the US Department of Energy made grants totalling $258 million under its SunShot Initiative in 2011, designed originally to cut the cost of utility-scale solar projects by three quarters, to $1 per Watt of nameplate capacity, by 2020. The grants are intended to increase solar cell efficiencies, reduce the cost of the balance of plant of solar farms, and improve the electronics that link solar systems to the grid. Bloomberg New Energy Finance estimates that the cost of utility-scale solar, including balance of plant and engineering, procurement and construction, was around $2.65 per Watt in 2011.

Investment in biofuels R&D fell 11% to $1.9 billion in 2011, but remained the second largest sector. Investment stagnated or fell modestly in most regions, and in Europe dropped $90 million to $565 million. Bucking the trend were Brazil, where spending rose $6 million to $123 million, with the increase evenly split between government and corporate investment; and the US, where investment inched up to $936 million, as a rise in corporate spending just offset falling public investment.

In biofuels, the imperative remains to develop and improve next-generation technologies that do not compete directly with food production, such as ligno-cellulosic biofuels and thermochemical technologies.

In ligno-cellulosic biofuels, where significant players include US company Poet and Spanish group Abengoa, one outstanding problem is that the process requires two different enzymes – one to break down the lignin, and another to ferment the sugars – which require very different temperatures and levels of acidity. That means they must be kept in separate tanks, raising the capital cost of the production plant. If enzymes could be designed to work in the same conditions, then the size of the plant and capital costs could be significantly reduced. Reducing the costs of the enzymes themselves – which are not yet produced in bulk – is another area for research.

Among thermochemical technologies, the focus is also to improve the performance of existing processes. In the field of gasification-fermentation, for example, companies such as Fulcrum Energy of the US are working to optimise gasifier performance and the match between feedstocks and fermenting bacteria. Among Fischer Tropsch developers, companies such as Sundrop and Rentech are working to improve the catalysts that turn syngas into liquid fuels, and to produce more reliably not only ethanol but also renewable diesel. In pyrolysis, where solid feedstocks are converted directly to liquid by being heated without oxygen, the main effort from companies such as KiOR, UOP and Dynamotive is to produce sufficient quantities of bio-oil to attract petrochemical refiners, and to reduce contaminants such as sulphur.

As the most mature renewable energy industry, it is perhaps not surprising that wind attracted less R&D investment than solar or biofuels. And given the difficult trading conditions for quoted turbine makers such as Vestas (see Chapter 6 on Public Markets), it is also no surprise that the sector generated less R&D spending than it did in 2010 – down 23% to $1.2 billion. More than two thirds of the decline was in corporate spending, and the biggest cuts were in China, down 59% to $88 million; Europe, down 22% to $312 million; and the US, down 25% at $38 million.

Yet there remain pressing R&D tasks for the wind industry, principally to develop turbines better suited to harsh conditions offshore, and also to onshore locations where wind speeds are lower than have typically been exploited so far. Both require longer rotor blades, and this has meant the adoption of tougher and lighter carbon-fibre composites from other industries such as aviation.

For the offshore market, Vestas, the world's biggest turbine maker, has developed a 7MW model with a rotor diameter of 164 metres, roughly double that of a typical onshore turbine, meaning each blade is the length of nine London Routemaster buses. For onshore lower wind locations, GE has developed a 1.6MW model with a rotor diameter of 100 metres, producing more power than the previous 80-metre version. Most manufacturers continue to produce blades in several sections, but Siemens has developed a proprietary process to cast blades in a single piece, making them stronger and less prone to cracking.

The industry also continues to investigate floating platforms so wind farms can be sited in deeper water further offshore, where wind speeds are higher. Toward the end of 2011, the Japanese government announced it will provide grants of $163 million to fund a demonstration project for six floating turbines, in water depths of more than 100 metres and sited at least 20 kilometres offshore from the coast of Fukushima.

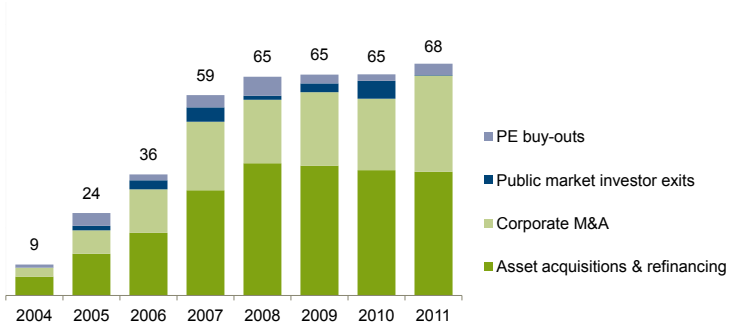
MERGERS AND ACQUISITIONS

- Total spending on mergers and acquisitions in renewable energy rose $3 billion to an all-time high of $68 billion in 2011.
- Corporate M&A – the buying and selling of companies – jumped 34% to a record $28 billion, but asset sales and refinancing slipped 1% from their 2010 peak, to $37 billion.
- Total M&A volumes reached record levels in wind ($42 billion) as two European utilities bought out their renewable power subsidiaries, and also in solar ($17 billion), as the sector began to consolidate apace in the face of massive overcapacity. PV asset purchases in Italy and solar thermal project refinancing in Spain were two of the drivers for solar.
- Activity fell 38% in biofuels to $5 billion, despite the continued consolidation of Brazil's fractured ethanol industry.
- Oil companies and insurers bought into wind and solar, while engineers built stakes in marine energy and solar thermal electricity generation.
- Activity in Europe jumped $9 billion to $35 billion, not far short of its 2008 peak, but fell by a fifth in the US, and almost two fifths (38%) in China.

Fear and greed vied for corporate investors' hearts in 2011, as renewable energy share prices continued to fall, exposing tempting targets. Sliding valuations offered potential bidders the prospect of buying renewable energy companies much more cheaply than would have been the case in previous years, but also the fear that if prices continued to fall, they might soon be exposed as having paid too much.

In the event, acquisition volumes increased $3 billion to a record $68 billion (see Figure 58). Asset acquisitions fell back 1% from their 2010 peak to less than $37 billion, while corporate M&A leapt 34% to mark a record $28 billion. Half of the corporate M&A was completed in the third quarter alone, making a quarterly record of $14 billion, of which $10 billion was due to just two deals by utilities buying out their renewable power subsidiaries.

FIGURE 58: ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY TYPE, 2004-2011, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

The value of corporate M&A deals can be measured in a number of ways, but the method used here is by enterprise value (debt plus equity). In addition, for deals in which control changed hands – 50% or more of the equity was bought –

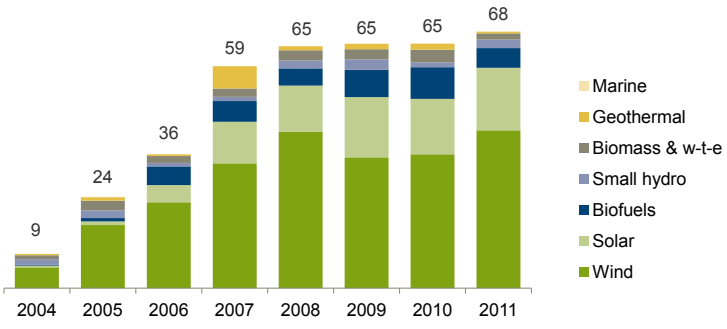
the whole enterprise value of the entity is included, whereas if the shareholding changing hands is less than this, only the part of the enterprise value equivalent to that percentage is counted.

On this basis, the biggest deal was by the French utility EDF, the world's biggest provider of nuclear electricity, which bought out the 50% of EDF Energies Nouvelles it did not already own, for $7.9 billion. The transaction included $5.7 billion of net debt, so the cash cost to EDF was $2.2 billion.

EDF executives justified the move by saying renewable power projects are becoming larger and more complicated, and denied it had anything to do with the post-Fukushima backlash against nuclear. Shares in EDF Energies Nouvelles, predominantly a wind project developer but with rapidly growing solar interests, had fallen to around 40% below their 2007 peak, and may have looked undervalued to EDF. The company plans to have 4.2GW of installed wind capacity and 500MW of solar by the end of 2012.

EDF's move followed a similar deal by Iberdrola, Spain's largest utility, which bought the 20% of Iberdrola Renovables it did not already own for $2.1 billion, with the subsidiary's shares languishing at scarcely half their 2007 IPO value. The valuation was not helped by retroactive changes to Spain's feed-in-tariffs for PV, nor by plunging natural gas prices in the US, and Iberdrola Renovables had already slashed its investment plans by a third. Nevertheless, analysts described the share price as absurd, and Iberdrola's deal as logical. Not all investors were happy however at the sight of a large utility floating 20% of its subsidiary's shares in 2007, and then buying them back for much less three and a half years later.

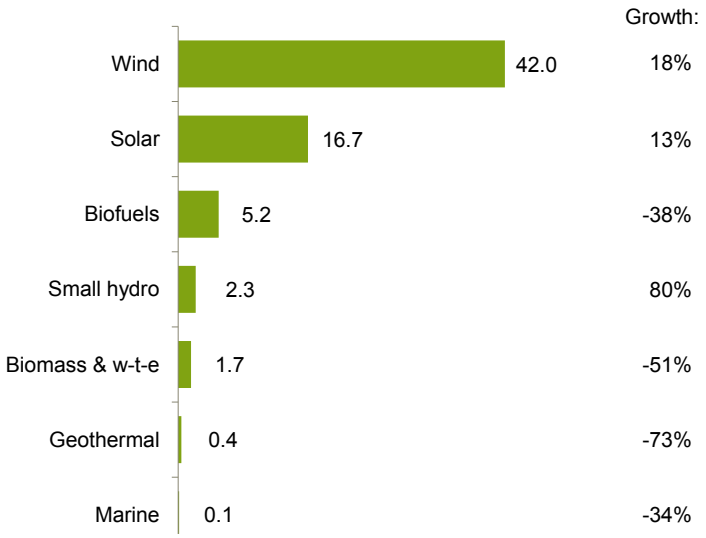
FIGURE 59: ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY SECTOR, 2004-2011, $BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

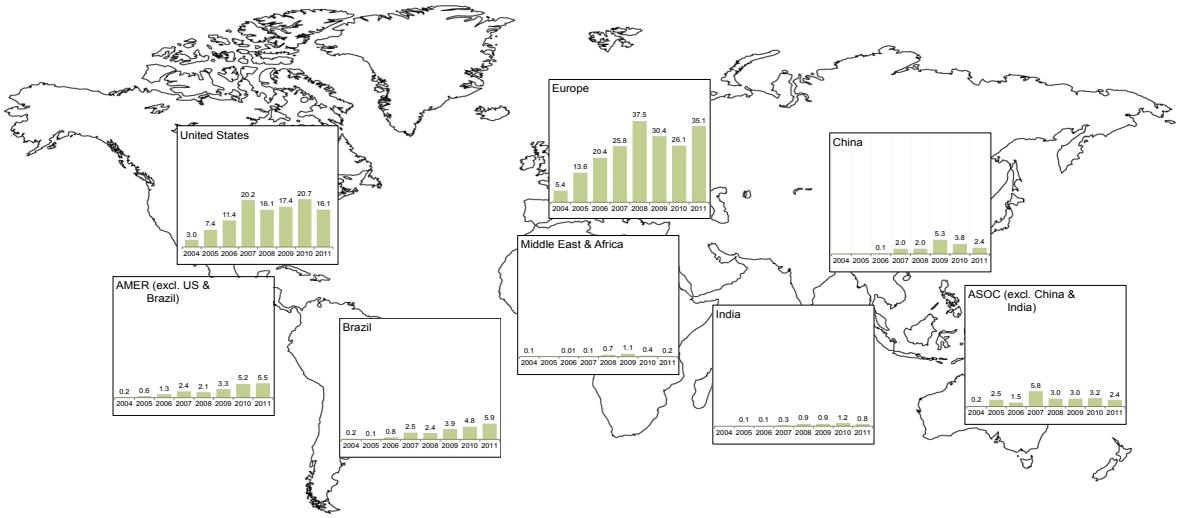
FIGURE 60: ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY SECTOR, 2011, AND GROWTH ON 2010, $BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

FIGURE 61: ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY REGION, 2004-2011, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

Had it not been for these two large deals, acquisition spending on companies and assets in the wind sector would have fallen back to levels not seen since 2007 (See Figures 59 and 60); wind asset acquisition and refinancing fell slightly compared to 2010, to $23.3 billion. Record volumes in solar, however, were much more broadly based, as the merciless consolidation of the companies under pressure from structural overcapacity continued apace, and as asset acquisition jumped by 42% to $8.8 billion.

The increase in solar asset acquisitions and refinancing would have been marginal had it not been for a single deal in the US. Warren Buffett's Mid-American Holdings bought the Topaz Solar Farm project from developer First Solar. The terms were not disclosed, but Bloomberg New Energy Finance analysts estimate the value of the 647MW thin-film PV project at $2.4 billion.

Italy saw the highest figure for solar asset acquisition business, at $3 billion, up from $2 billion in 2010. This reflected the boom in solar PV installations stimulated by the country's generous feed-in-tariffs over the last two years. Italy installed well over 7GW in 2011, more than twice the 2010 figure and 10 times that for 2009, as developers rushed to complete projects and lock in tariff rates – now much reduced by successive Conto Energia renewable energy laws.

The most acquisitive investor by far was the British private equity firm Terra Firma, which splashed out more than EUR 1 billion ($1.4 billion) on Italian solar assets during 2011. In March, it bought Rete Rinnovabile from Italy's grid operator Terna for EUR 641 million ($910 million), in Europe's largest ever solar deal. Rete is Italy's biggest solar generator, and boasts a portfolio of 62 PV plants with a combined capacity of 144MW. In May, Terra Firma snapped up 19MW from Sorgenia Solar for EUR 98 million ($140 million), and in October it bought another 77MW PV portfolio from Terna for EUR 264 million ($367 million). As a result of these deals, Terra Firma was named the leading venture capital and private equity investor in Bloomberg New Energy Finance's 2011 Clean Energy League Tables.

Analysts say the boom in asset sales may represent an element of 'catch-up'. Developers who would traditionally have sold projects to financial investors at an earlier stage found they could not do so during the boom because of increased risk aversion as a result of the euro area crisis. So projects were sold or refinanced after completion, once construction risk had been eliminated. The

installation boom should fade as Italy approaches self-imposed limits to solar subsidies, but the asset acquisition frenzy is likely to continue for some time as pension funds enter the market.

Another quarter of solar asset acquisition and refinancing volumes were due to Spain. Here, the main business was not in photovoltaics – where installation volumes are much reduced following the imposition of retroactive cuts to feed-in tariffs at the end of 2010 – but to a handful of big deals in solar thermal. The biggest single transaction was the EUR 319 million ($457 million) refinancing of the Moron de la Frontera solar thermal project by Solar Millennium in July. The 50MW parabolic trough plant near Seville was due to open in 2013, but the future of the project is uncertain since Solar Millennium filed for insolvency at the end of the year and administrators are trying to sell its projects.

Solar Millennium was only one of several insolvencies in the solar sector (see Public Markets chapter), caused by overcapacity and fierce competition from China. Solar Millennium was focused on solar thermal projects, but found itself undercut by the plunging price of photovoltaic technology. The same factors also drove consolidation through mergers among PV companies, and encouraged new bidders to venture in from outside the sector.

China saw some of the biggest deals of the year. The Zhejiang Haitong Food Group reversed into Changzhou Eging Photovoltaic Technology at a cost of $978 million, and the plastics manufacturer Jiangsu Shenlong Hi-Tech Group bought Hareon Solar Technology for $368 million.

Elsewhere, competitive pressures encouraged vertical integration as manufacturers tried to capture a guaranteed sales channel for their output and widen their margins. In Europe, German module maker SolarWorld bought SolarParc, a Danish project developer, for EUR 62 million, ($84 million), and in the US, MEMC Electronic Materials, a solar wafer manufacturer, bought project developer Fotowatio Renewable Ventures, for $135 million.

One of the most striking deals of the year saw Total, a member of the world's five "supermajor" oil companies, buy a 60% stake in SunPower, the second largest solar panel maker in the US, for $1.6 billion. The deal was applauded by some analysts, who said it would give SunPower the financial muscle to compete with state-supported Chinese competitors, and for Total a natural hedge against high oil prices and depleting reserves. However, Total might have done better to wait; its CEO, Christophe de Margerie, has since said SunPower would have gone bust had the oil company not intervened, implicitly conceding they could have acquired it for much less.

Total was only one of several oil companies to buy into renewable energy in 2011. Repsol, Spain's largest oil company, bought an 80% stake in SeaEnergy Renewables, a British offshore wind developer, for GBP 42 million ($67 million). The company has stakes in three projects, and Repsol has formed a partnership with EDP Renovaveis, the renewables unit of the Portuguese utility, to develop two of them.

In a more conventional move, BP bought an 83% stake in Brazilian ethanol producer Cia Nacional de Acucar e Alcool for $680 million. BP said when the company's assets are fully developed they will raise BP's ethanol production to 1.4 billion litres, or 9 million barrels, per year. The BP acquisition follows the much larger joint venture between Shell and Cosan in 2010, now renamed Raizen, which formed the world's biggest ethanol producer and aims to produce five billion litres per year.

The BP deal also heads a list of six big biofuel corporate M&A deals in Brazil with a combined value of almost $2.1 billion, about two thirds of the $3.2 billion in biofuel mergers done globally in 2011. As the fractured sector continued to consolidate, Brazil Ecodiesel acquired crop producer Vanguarda do Brasil for $428 million; Cosan bought Usina Zanin Acucar e Alcool for $197 million; and Vale, the world's largest iron ore producer, took a 70% stake in Biopalma da Amazonia for $174 million. The miner intends to run its mining equipment and fleet of trains on a 20% blend of biodiesel.

Oil companies were not alone in seeking an entré to renewable energy. Major engineering companies were also busy building positions in some of the less mature technologies. In solar thermal electricity generation, ABB took a 35% stake in Novotec Solar, the German Fresnel technology developer, with an option to buy the entire company; GE took an undisclosed stake in eSolar, the Californian tower and heliostat developer; and Mitsubishi paid EUR 46 million ($63 million) for a 15% stake in Acciona Termosolar of Spain. In the marine sector, Siemens bought a 45% stake in Marine Current Turbines, the British tidal stream developer, and Alstom acquired 40% of AWS Ocean Energy, the Scottish wave power company.

Small hydro was a bright spot, as total corporate M&A volumes quadrupled to $1.2 billion, largely because of three Canadian mergers totalling $908 million. Alterra Power, a Vancouver-based geothermal developer, bought Plutonic Power for $409 million; privately held BluEarth Renewables acquired Ontario-based ACH for $307 million; and Innergex Renewable Energy bought Cloudworks Energy for $192 million.

Other novel investors in renewable energy included the reinsurance giant Munich Re, which bought a 49% stake in T-Solar from Isolux, and Axa Private Equity Insurance, a unit of Europe's second biggest insurer, launched a joint venture to invest in Italian solar PV. Google, meanwhile, invested $500 million in an Oregon wind farm project, together with Japanese trading houses Itochu and Sumitomo, as well as $168 million in the massive Ivanpah STEG project being developed by BrightSource in Southern California.

Figure 61 shows that Europe, fuelled by the two big utility squeeze-outs and asset purchases, dominated overall acquisition activity in renewable energy worldwide in 2011, with $35.1 billion worth of deals. In second place was the US with $16.1 billion, and Brazil was third with $5.9 billion.

INVESTMENT SOURCES

- Shares in clean energy funds – those focused most tightly on renewable energy - fell 31% on average in 2011, while more broadly based "environment" and "climate change" funds dropped 20%.
- Only three new funds investing in clean energy or climate change public equities came to market in 2011, down from a peak of 45 in 2007. Venture capital funds also found it tough to raise new capital, but there was more success for private equity funds specialising in investing in renewable energy projects.
- There was also evidence of the growing importance of green bonds. In early 2012, an $850 million bond issue for a project owned by Warren Buffett's MidAmerican Holdings raised hopes for greater direct investment from the capital markets in renewable energy projects.
- Pension funds remain an important potential source of finance for renewables, particularly for operation-stage projects. PensionDanmark has been one of the pioneers, but many other funds are being held back by a shortage of de-risked, pooled products, and by a lack of familiarity with the sector.
- Some Western developers are targeting Chinese state-backed financial institutions as a source of debt for their projects.

FUNDS

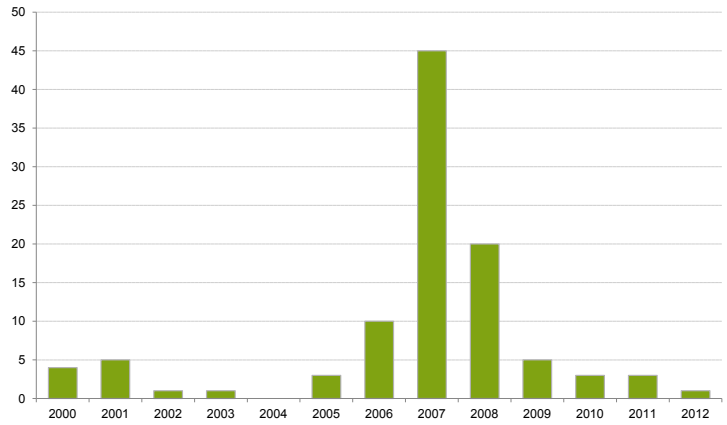
Funds investing in publicly quoted companies in clean energy and climate-related themes faced brutal conditions in 2011. The WilderHill New Energy Global Innovation Index, or NEX, slumped 40%, while the Nasdaq and S&P500 indices ended the year almost exactly where they started. The underperformance was largely due to overcapacity in the wind and solar manufacturing sectors, leading to fierce competition and plunging product prices. This in turn prompted widespread cuts to renewable support regimes in Europe. The sector was also sideswiped by historically low gas prices in the US, and the sovereign debt crisis.

It was no surprise then that public equity funds fared badly too. In total, funds tracked by Bloomberg New Energy Finance saw the value of assets under management shrink by 34%, as the price of underlying shareholdings slumped, and as investors redeemed shares in the funds. Overall, there were just three new public equity funds launched in 2011, specialising in clean energy or wider climate change themes, compared to a peak of 45 in 2007 (see Figure 62).

Clean energy public equity funds, those that are significantly focused on renewable energy, fared worst in terms of performance in 2011. Shares in the 16 funds in this group with assets of more than EUR 100 million fell 31% on average, albeit with significant variations. The worst performer was the Guggenheim Solar Fund, which dropped almost two thirds in value (65%), perhaps not surprising given its exposure to a sector under so much competitive pressure. The fund's biggest holding, First Solar, fell 75% during 2011.

The best performer was the New Alternatives

FIGURE 62: NUMBER OF SUSTAINABLE ENERGY PUBLIC EQUITY FUNDS LAUNCHED, 2000-2012



Source: Bloomberg New Energy Finance

Fund, which lost only around 8.5%. The fund aims to hold around a quarter of its assets in alternative energy companies such as wind turbine and PV manufacturers, but also holds stocks in European utilities and project developers. This mix helped cushion the losses.

The 19 "environment" and "climate" funds with assets of more than EUR 100 million fared better than those focused on renewable energy. Environment funds are defined as those that invest in companies producing a broader range of environmental goods and services such as waste management or water treatment, and climate funds as those that seek out mainstream companies that have remodelled their business practices to mitigate climate change impacts. Both approaches protected funds against the steep falls in renewable energy stocks, and shares in the environment and climate funds fell 20% on average.

Managers of some venture capital and private equity funds succeeded in raising new money to invest in clean energy and climate related themes.

One of the biggest hauls was achieved by Impax Asset Management, which closed its Impax New Energy Investors II fund at EUR 330 million ($450 million) in September 2011. Part of the proceeds had already been spent in 2010 in buying the Epuron France wind business, and shortly after the fund closed, Impax bolstered this with the acquisition of another 100MW of wind capacity in France and Poland from Eolia Renovables. That fundraising was significant because more than half of the money was raised from UK pension funds.

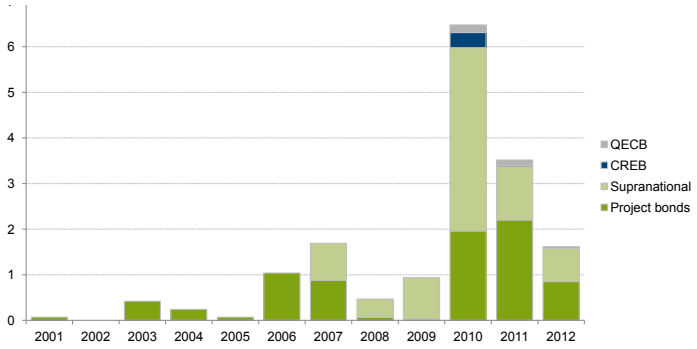
The German venture capital firm eCapital raised EUR 50 million ($70 million) with backing from the German insurer LVM Versicherungen. Geneva-based Unigestion achieved a first close for its Ethos Environmental Sustainability Fund of around EUR 68 million, raised from pension funds and insurers.

Zouk Capital, the London-based private equity firm, achieved close on its Cleantech Europe II fund at EUR 230 million ($328 million) in June 2011. The fund will invest in renewable energy projects, energy efficiency and water and waste technologies, in north-west Europe. Another London-based manager, HgCapital raised EUR 545 million for its second Renewable Power Partners Fund, adding to the EUR 300 million of its first fund.

Also in the UK, Hazel Capital led a group of companies raising funds to plough into renewable

energy projects via Venture Capital Trusts and Enterprise Investment Scheme funds, both of which offer generous tax breaks to investors. Hazel's two VCT funds closed with GBP 41.6 million ($68 million), to invest in a wide range of renewable technologies. The UK government announced that from April 2012, VCT and EIS funds will not be allowed to invest in projects receiving feed-in tariffs.

FIGURE 63: TIER 1 GREEN BOND ISSUANCE, 2001-2012, $BN



QECB = US Qualified Energy Conservation Bond programme
CREB = US Clean Renewable Energy Bond programme
Sources: Bloomberg New Energy Finance, Bloomberg Terminal

Danish private equity fund manager Frontier Investment Management reached close at EUR 60 million on a renewable energy and carbon credit fund, specialising in emerging economies in sub-Saharan Africa, including Kenya, Mozambique, Tanzania, Uganda and Zambia.

Aside from the fundraisings that concluded during 2011, confidence in the sector was signalled by a number of fund launches and announcements. The US tech investor Silver Lake launched a new clean energy fund, Silver Lake Kraftwerk, with a $300 million investment from Soros Fund Management, and a final target of $1 billion. The fund will back companies using technology and new business models to raise the efficiency of energy production, and cut waste and emissions.

Also in the US, a group of 11 wealthy families formed the Cleantech Syndicate, which plans to invest up to $1.4 billion over five years in renewable generation, energy efficiency, at all stages of development from seed funding to project finance.

Elsewhere, Wheb Ventures announced it is to close its second environment fund and start a third, targeting EUR 250 million ($342 million); China's Grand River Capital said it plans to raise $100 million for its SinoGreen Fund; Origo Partners and Ecofin teamed up to raise $200 million for a China-focused clean energy fund; and NextEnergy Capital pledged to raise EUR 400 million ($536 million) for renewable and environmental investments in Africa.

GREEN BONDS

In 2011, there was increasing awareness of the importance of green bonds to future investment in clean energy. There are estimated to be some $243 billion in green bonds outstanding, of which $233 billion worth are corporate bonds issued by companies in clean energy or low-carbon industries, and $10 billion are bonds issued by international financial institutions or project developers to fund projects directly.

Figure 63 shows the trend in issuance of "tier 1" green bonds – these include project bonds, bonds issued by financial institutions such as development banks, and those issued under US municipal green debt programmes known as QECB and CREB. The chart excludes bond issues by corporations active in the sector. Although the trend has been up, the rate of issuance is still far below what would be required to make much contribution to the $600 billion that the world needs to invest per year by 2020 to bring emissions to a peak (see Chapter 2). Barriers to growth include the absence of standard terms and conditions, along with manufacturers' reluctance to submit performance data for their devices. Attempts are being made to address the first of these issues. The Climate Bonds Initiative, a non-governmental organisation that promotes green bonds, has developed a Climate Bonds Standard, which should help build investor confidence.

Another barrier is the risk profile of project bonds, which could deter many institutional investors. Before the financial crisis, riskier bonds could be insured through specialist monoline insurers, to raise their credit-rating to levels acceptable to big investors, but this market has collapsed under the weight of subprime mortgage losses. So now the European Commission has launched the 2020 Project Bond Initiative, in which the European Investment Bank will assume the riskiest part of the debt of major infrastructure projects in order to raise the credit rating of the project as a whole, so private investors can take part.

The only European renewable energy project bond issue of note since the financial crisis was a EUR 195 million exercise by SunPower in December 2010, to finance the 44MW final phases of its Montalto di Castro PV plant in Italy.

In the US, however, recent months have produced a high-profile deal that could start a trend. In February 2012, MidAmerican Energy Holdings, a company controlled by Warren Buffett's Berkshire Hathaway, sold $850 million worth of bonds for its 550MW Topaz PV project in California. The issue was originally set at $700 million, but it was heavily over-subscribed. The 27.5-year bonds were priced at around 380 basis points over the corresponding Treasuries.

LONG-TERM INVESTORS

Bond issues could, in time, be an important instrument for bringing pension and insurance fund capital into the financing of renewable energy projects. At present, pension funds hold less than 1% of their total assets in infrastructure investments of any kind[22], and only a fraction of that one percentage point in renewables. However, with US, German, Japanese and UK 10-year government bond yields all at or below 2%, these investors are hungry for safe assets that pay higher returns.

22. OECD Working Papers on Finance, Insurance and Private Pensions No. 13: Pension Funds Investment in Infrastructure

PensionDanmark, one of Denmark's largest pension funds, has set itself the objective of holding 10% of its assets in renewable power projects within a few years. In March 2012, its chief executive said it had invested $1.5 billion in renewables, out of total assets of $23 billion. Among the deals it has done have been the purchase of a 50% stake for $120 million in the Nysted operating offshore wind farm from Dong Energy in September 2010, and a large contribution in October 2011 to the EUR 250 million of debt required for the 200MW Jadraas onshore wind project in Sweden, being developed by Platina Partners and Arise Windpower.

Other pension funds have not been so bold – so far. However other organisations have started to try to tailor clean energy offerings to attract pension money. In May 2011 for instance, Asian Development Bank said it would start a $5 billion fund to channel cash from pension and sovereign wealth funds into low-carbon energy projects in its region. And several of the private-sector funds mentioned above, including those of Impax and Unigestion, received contributions from the pension sector.

Some insurers have been making direct investments in renewable energy assets for years, and are now raising their exposures. Munich Re said in June 2011 that it planned to invest EUR 2.5 billion in assets such as wind farms and solar parks over the ensuing five years, while Allianz said in August that it aimed to add more renewable energy assets to its portfolio on top of the EUR 1 billion worth it had amassed over the previous five years.

CHINESE MONEY FOR WESTERN PROJECTS

Another potential source of investment dollars for renewable energy projects around the world is from Chinese state-backed corporations and banks. In December 2011, China Three Gorges Corporation agreed to pay EUR 2.7 billion for a 21% stake in EDP of Portugal, an important developer of wind projects on both sides of the Atlantic. China Three Gorges also said it would put EUR 2 billion into equity stakes in operational and late-stage development projects of EDP, and bring on board an unnamed Chinese financial institution to provide EUR 2 billion in credit facilities for EDP.

Some developers in the West are seeing the purchase of Chinese technology as a way of attracting Chinese finance to their projects. In July 2011, Irish company Mainstream Renewable Power signed a deal with a Chinese turbine maker for 1GW of wind projects in Ireland. It said it planned to negotiate debt from China Development Bank, and might sell equity stakes in due course to other Chinese institutions. Mainstream has already agreed loans from China Development Bank to finance wind projects in Chile.

GLOSSARY

ASSET FINANCE	All money invested in renewable energy generation projects, whether from internal company balance sheets, from debt finance, or from equity finance. This excludes refinancings. The asset finance numbers represent investment raised in each year – i.e., equity that is committed, or debt that is provided (sometimes in tranches). The plant or project may not be commissioned in the same year.
CAPITAL EXPENDITURE – CAPEX	Funds used by a company to acquire or upgrade physical assets such as property, industrial buildings or equipment. Some investment will translate into capacity in the following year.
CONVERTIBLE BOND	A bond that can be exchanged for a fixed number of shares in the issuing company.
DISTRIBUTED GENERATION	Generation of power from small-scale technologies close to where it is used.
FEED-IN TARIFF	A premium rate paid for electricity fed back into the electricity grid from a designated renewable electricity generation source.
GREEN STIMULUS	The share of government economic recovery packages allocated to "green" initiatives such as renewable energy, energy efficiency, smart power grid, transport, and other clean energy technologies.
INITIAL PUBLIC OFFERING (IPO)	A company's first offering of stock or shares for purchase via an exchange. Also referred to as "flotation".
INVESTMENT TAX CREDIT (ITC)	Allows investment in renewable energy in the US to be deducted from income tax.
MERGERS & ACQUISITIONS (M&A)	The value of existing equity and debt purchased by new corporate buyers in companies developing renewable technology or operating renewable energy projects.
NON-RECOURSE PROJECT FINANCE	Debt and equity provided directly to projects rather than to the companies developing them. The lender is only entitled to repayment from the profits of the project and has no access to the borrower's other assets in the event of default.
OVER-THE-COUNTER (OTC)	Trading of stocks, bonds, commodities or derivatives directly between buyers and sellers as opposed to via a formal exchange.
PRIVATE INVESTMENT IN PUBLIC EQUITY (PIPE)	The purchase of securities directly from a publicly traded company by private investors.

PRODUCTION TAX CREDIT (PTC)	The support instrument for wind energy projects at federal level in the US.
PUBLIC MARKETS	All money invested in the equity of publicly quoted companies developing renewable energy technology and clean power generation. Investment in companies setting up generating capacity is included in the asset financing figure.
RENEWABLE PORTFOLIO STANDARD (RPS)	A regulation that requires that a minimum of electricity or heat sold is from renewable energy sources. Also called Renewable Electricity Standard (RES) at the United States federal level and Renewables Obligation in the UK.
TAX EQUITY	Tax equity investors invest in renewable energy projects in exchange for federal tax credits.
VENTURE CAPITAL AND PRIVATE EQUITY (VC/PE)	All money invested by venture capital and private equity funds in the equity of companies developing renewable energy technology. Similar investment in companies setting up generating capacity through special purpose vehicles is counted in the asset financing figure.

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Bloomberg
NEW ENERGY FINANCE

Global investment in renewable power and fuels increased 17% to a new record of $257 billion in 2011. Developing economies made up 35% of this total investment, compared to 65% for developed economies.

The US closed in on China in the race to be the lead investor in renewable energy, with a 57% leap in its outlays to $51 billion. India however displayed the fastest expansion rate for investment of any large renewables market in the world in 2011, with a 62% increase to $12 billion.

One of the dominant features of the renewable energy landscape in 2011 was falling technology costs. Photovoltaic module prices fell by close to 50%, and onshore wind turbine prices by around 10%. These changes brought these two leading renewable power technologies closer to competitiveness with fossil-fuel alternatives such as coal and gas.

The other key feature was a weakening in policy support for renewable energy in many developed countries. This reflected austerity pressures, particularly in Europe, and legislative deadlock in the US Congress

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